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FOR PROMOTING EXPERIMENTS IN
HORTICULTURE

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Visits may be paid to the Research Station on any week day *by appointment* (Saturday afternoon only under exceptional circumstances).

Passenger Station : East Malling Halt. Southern Railway.

Goods Station : Aylesford.

Bus Services by the Maidstone and District Bus Co., every 20 minutes from Maidstone to East Malling Church.

Ditton Corner on the main London—Maidstone Road (with Red Lamp Danger Signal) is the turning to the Research Station for visitors coming by road.

Telephones : The Station is now served by two lines :

Research Station, *Administrative*—(Aylesford 7229).

Research Station, *Advisory and Technical Service*—(Aylesford 7189).

EDITORIAL AND INTRODUCTORY

IN the past it has been customary for a statement of the Station's general development and activities to be presented by the Executive to the Annual General Meeting and sent not only to our Associate Members but used for general circulation. Owing to the need for drastic economies it has been decided from now onwards to print this statement as a supplementary pamphlet for the use of our Committees and Members only, and to issue an Annual Report of Research Work to be made up of four sections as follows :—

- I. The Experimental Farm.
- II. General Review of Research Work.
- III. Preliminary Research Reports.
- IV. Bulletins for Fruitgrowers.

Thus the two parts (I. General and II. Supplement) of the Annual Report previously issued will now be more or less merged into a single volume, and the details of administrative and extension activities circulated separately to our Members as explained above.

In some years one section of the volume will be liable to be more amplified than another, according as the activities of the Research Staff vary. To this volume all our Associate Members will be entitled.

Section I

THE EXPERIMENTAL FARM

By J. AMOS, F. H. BEARD AND A. C. PAINTER

INTRODUCTORY.

IN presenting the report on the general work of the Farm for 1932 we would again ask our readers to bear in mind the introductory remarks that were made in the last Annual Report, all of which apply with equal force to the year under review.

We are not attempting to present figures for the running of a commercial business, but merely to state in terms of market value some of the experiences gained from the sale of fruit from our experimental plots.

FARM REPORT

GENERAL.

A slight fall of snow in February and seven days of severe frost in March were the only winter conditions experienced during the first three months of the year. Apart from this, weather conditions were generally ideal for all farm operations. April and the greater part of May were dull, with considerable showery periods; this made cultivations difficult and expensive. A spell of high temperatures from the 14th to the 19th of May caused the apple blossom to open rapidly and the stage known as "pink bud" was of very short duration. In consequence of this our routine "pink bud" scab spray was in some cases applied when the centre flowers of the trusses were open. The dull weather during May coupled with the very dry conditions in June adversely affected the strawberry crop and delayed the ripening of the fruit, the first picking on the 25th being six days later than in 1931. The hot dry conditions also reduced the number of pickings.

During the last week of July and the first week in August heavy rains seriously affected the picking and marketing of black currants, otherwise these two months were hot and dry. September and October were generally fine and harvesting and fruit-picking were carried out with little hindrance. Mild conditions with little rain during the remaining two months of the year were ideal for early planting and other farm work.

FRESH PLANTINGS, GRUBBING, ETC.

Twenty-four varieties of Pears worked on Quince stock have been planted as cordons on Great East Field. These will serve as a "library" and for the study of varietal characteristics. A further series comprising nine varieties have also been planted as cordon sand will be used to study the effects of various methods of summer and winter pruning.

In order to compare the behaviour in the field of bench grafted trees worked on to piece roots of known layered stocks a batch of 3 year old Lane's Prince Albert has been planted out as bush trees on Church Field. Care will be taken to see that these trees do not become scion rooted, and that the root portions do not become exposed to light.

Considerable thinning out, by the removal of trees and bushes on overcrowded plots due to interplanting and the grubbing of entire plots which have served their purpose experimentally has been carried out during the past winter.

On the Egham Field some three acres of 11 year old plums, considerably reduced in number, owing to disease, have been taken out, leaving a permanent 15 foot plant of 9 year old pears. A further three acres of 10 year old plums, interplanted with varieties of pears and black currants, has had the two latter crops removed. This now leaves plums at 15 foot square.

One and a half acres, consisting of some thirty-six varieties of raspberries, interplanted between black currants, which have been used as a variety cropping trial for the past seven years, have also been removed.

Further small plantings of all the chief varieties of raspberries and black currants have been established elsewhere to serve as a nucleus for future work.

A plot of 10 year old bush trees of Stirling Castle, interplanted between Cox's Orange Pippin for pollination, have been over budded and grafted. This has become necessary owing to the serious damage that occurs on this variety when sprays containing sulphur are used on the Cox's.

On the Great East Field three-quarters of an acre of Goliath black currants, which has been used for Big Bud spraying trials, has had to be grubbed. This was due in part to the rapid spread of "Big Bud" and "Reversion" owing to the leaving of unsprayed bushes as controls.

The remaining plot of 13 year old Bramley's Seedling and Worcester Pearmain was sown down to Perennial Rye Grass in the spring, and will be used to test out methods of manuring through grass.

On the Newgates Field some 8 acres have been cleared; viz. 6 acres of 8 year old Baldwin black currants and 2 acres of 8 year old Lloyd George raspberries.

These two plots had up to the time of grubbing been under different manurial treatments and had reached a stage which did not justify continuance either experimentally or commercially. The whole of this area was heavily manured, ploughed, and sub-soiled and has been planted as follows:—

The 6 acres with Mosaic free Lloyd George raspberry canes, and the two acres with two varieties of black currants, Triple X, our heaviest cropping seedling, and Baldwin. These two varieties of blacks have been planted at varying distances and are being subjected to different pruning treatments.

The alleys between the rows of raspberries and black currants have been temporarily utilized for bedding stocks.

Although the 5 acres of Royal Sovereign, autumn planted 1931, wintered badly, after regapping in the spring, a strong plant has been secured. Some 100,000 first class runners were distributed in the autumn from one acre which was especially reserved for the purpose.

The 8 acres of stool beds on the Newgates Field have given a very high yield of well rooted layers. These, and also the bedded stocks, have met a ready and increasing demand.

In the Newgates "shaw" rides 40 feet apart have been cleared and have been planted up with a variety collection of walnuts.

On the Upper Grubb Field some 3 acres were planted with bedded stocks. Many of these have been left in situ and will be stooled to further increase the supply of layered rootstocks, the demand for which exceeds the supply.

SPRAYING.

The appendix on page 20 gives the routine spraying that has been carried out during the past year and which has generally proved successful. One disturbing factor, however, was the serious russetting of the fruit that occurred on many varieties where

the pre-blossom lime-sulphur spray was followed by a capsid wash of soft soap and nicotine.

On certain plots Red Spider was serious but the two sprays used, viz. lime-sulphur or Summer petroleum on sulphur-shy varieties, checked the pest.

Now that considerable areas of trees are reaching maturity the time occupied in spraying becomes a vital factor. In order to facilitate this work a new 10 h.p. plant was purchased in September. This was built jointly by Messrs. Drake & Fletcher and Messrs. Weeks & Son, of Maidstone, and has been made to meet the requirements of the Station. Our thanks are due to both firms for their ready collaboration with ourselves and each other in the equipment of this special model, and for their consideration to the Station in reducing the expenditure to the minimum.

The water supply has been extended to two additional points on the farm, thus eliminating the cost of water carting to a large extent. J.A.

MARKETING.

Perhaps the outstanding feature of the year was the very welcome recovery in the prices obtained for the various soft fruit crops. This was probably due in the main to three principal causes :

- (1) The tariffs imposed on the imports of fruit from foreign countries.
- (2) The increased demand for fruit for canning purposes.
- (3) The fact that the home crops were generally speaking only moderate.

As regards top fruits, plums were on the light side throughout the country, but the apple crop, especially in the case of cooking varieties, was considerably heavier than in the previous year and prices in consequence were as a rule well below last year's somewhat high level.

INDIVIDUAL CROPS.

Strawberries. (Area under cultivation— $2\frac{1}{2}$ acres in their fifth year ; 2 acres in their fourth year ; $1\frac{1}{2}$ acres in their third year and $1\frac{1}{2}$ acres in their second year, these last cropped for the first time. All these are Royal Sovereign with the exception of a small area given up to a collection of varieties.) Strawberries wintered badly and were very late in starting into growth. Royal Sovereigns gave a total yield of some $6\frac{1}{2}$ tons, this being 3 tons less than that of last season. The fruit, presumably owing to the bad start the plants made, the fact that most of them were in their fourth and fifth years, and the dry period experienced during the latter part of June, was mainly of poor size, the production of National Mark fruit, omitting the proportion that was purposely picked unsorted for the grading trial referred to below, being only 26 per cent of the crop compared to 50 per cent in the previous year.

Prices, however, were mainly good, " Extra Selected " National Mark fruit fetching from 9d. to 1s. a lb., " Selected " from 4d. to 10d., small fruit in 6 lb. chips from $3\frac{1}{2}$ d. to 6d., and the greater proportion of jam fruit between £35 and £40 a ton. Ungraded fruit in 3 lb. chips fetched 5d. to 7d. a lb.

The amount of fruit marketed under the different methods was as follows :—

" Extra Selected " in 1 lb. punnets	..	..	560 lbs.
" Selected " in 3 lb. chips	..	..	2,950 lbs.
Small fruit in 6 lb. chips	..	..	5,850 lbs.
Jam fruit in tubs	..	..	3,970 lbs.
Ungraded in 3 lb. chips	..	..	1,570 lbs.

Other varieties produced approximately $\frac{1}{2}$ ton of fruit, the total gross return for the 7 tons being in the neighbourhood of £340 or an average of £49 a ton.

The grading trial referred to in the last report was continued but, owing to other experimental requirements, it was only found possible to devote a small area to this purpose. Moreover the shortness of the season precluded more than four pickings being made. The area was divided into two plots, one of which was picked to National Mark Standards one day whilst the other was picked ungraded. At the following picking the opposite was done. The results, which are summarized below, went to confirm the conclusions drawn at the end of the previous season, viz. that to make grading to such standards as the National Mark worth while the fruit must be of a sufficiently high standard to begin with.

	1st and 2nd Pickings together.		3rd and 4th Pickings together.	
	Graded.	Ungraded.	Graded.	Ungraded.
Quantity Picked ..	497 lbs. d.	597 lbs. d.	859 lbs. d.	895 lbs. d.
Average gross price per lb.	7·0	5·6	5·4	5·4
Percentage of National Mark fruit picked ..	49%	—	28%	—

It is hoped next year to carry out a trial on a larger and more thorough scale.

Raspberries. (Area under cultivation—5 acres of 8 year old Lloyd George in Newgates Field and $1\frac{1}{2}$ acres of mixed varieties in Egham Field.)

The 5 acres of Lloyd George yielded a little over 14 tons of fruit and a gross return of £600 or £43 a ton. Maggot was again controlled by two sprayings of a Derris wash when in flower. (See Appendix, page 10.)

Fruit was once more on the small side. Good firm fruit of medium size and above was marketed in 3 lb. chips, with the exception of a small quantity which was put into punnets at the commencement of the season, but the fruit on the whole was not considered to be of sufficiently good quality for this package. The remainder was marketed in tubs, a small quantity being put into chips early on, when it was thought that prices would warrant it.

The approximate quantities marketed in these various ways was as follows :—

Selected fruit in	1 lb. punnets	300 lbs.
	3 lb. chips	5,800 lbs.
Other fruit in	3 lb. chips	1,100 lbs.
	tubs	23,300 lbs.

The selected fruit fetched from 5d. to 10d. a lb., while jam prices ranged from £35 to £40 a ton in marked contrast to the prices prevailing in 1931 when as low a figure as £16 a ton was touched.

The crop in Egham Field amounted to 16½ cwts. and fetched £31.

Gooseberries. (Area under cultivation—2 acres interplanted between bush pear trees consisting of a variety collection of Careless, Freedom, Greengage, Gunner, Keep-sake, Leader, Leveller, White Lion and Whitesmith, the bushes being from 4 to 12 years old.)

The crop was on the light side, the only variety that it was thought necessary to thin being White Lion. A portion of the Whitesmith was picked green, but owing

to the necessity for spraying the pears with Bordeaux against Scab, most of the fruit had to be left to ripen. In all some 800 lbs. of green gooseberries were marketed. These made £15.

Omitting Whitesmith, the crop of dessert fruit amounted to approximately $4\frac{1}{2}$ tons, and brought in some £155 gross or $3\frac{3}{4}$ d. a lb.

The fruit was marketed almost entirely in 6 and 12 lb. chip baskets and sold readily, being graded as last year, the quantities and prices under the different grades being as follows:—

Selected in 6 lb. chips—1,300 lbs. Price 4d. to 6d. a lb.
 Grade 1 in 12 lb. chips—4,000 lbs. Price 3d. to 5d. a lb.
 Grade 2 in 12 lb. chips—2,850 lbs. Price $2\frac{1}{2}$ d. to 4d. a lb.
 Grade 3 in 12 lb. chips—1,550 lbs. Price $2\frac{1}{2}$ d. to $3\frac{1}{2}$ d. a lb.
 Small in half-sieves—240 lbs. Price 2d. to $2\frac{1}{2}$ d. a lb.

Even the Whitesmith, which in previous years have often not paid for the picking, fetched not less than 4s. a half-sieve. $11\frac{1}{2}$ cwts. of this variety were marketed, mainly in half-sieves, the better fruit being put into 12 lb. chips, and made £14.

Red Currants. (Area under cultivation—about three-quarters of an acre inter-planted between bush apple trees and consisting of some twenty odd varieties from 7 to 9 years old.)

The crop, while good, was slightly less than that of last year, amounting in all to about $2\frac{1}{2}$ tons. On the other hand it brought in a rather higher gross return of some £92 or 4d. a lb.

The fruit was marketed as usual in 6 lb. chips. Whilst varieties such as Earliest of Fournal, Skinner's Early, Versailles and Laxton's Perfection sold well at prices ranging from 4d. to 9d. a lb., small fruited varieties such as Houghton Castle failed to bring in more than $2\frac{1}{2}$ d. to 4d.

Black Currants. (Area under cultivation—6 acres of 8 year old Baldwins in Newgates Field, planted 6 by 4, $2\frac{1}{2}$ acres of mixed varieties in Egham, $\frac{3}{4}$ acre in Great East, and 1 acre of new seedling crosses in Upper Grub.)

The Baldwin crop in Newgates Field was again sold by contract. After last year's big yield the crop was comparatively light, amounting to some $9\frac{1}{2}$ tons. The price obtained, however, was £38 a ton into buyers' empties against £19 the previous year and brought in £365 gross.

The variety trials in Egham Field again cropped well, yielding nearly 7 tons of fruit. The new East Malling Seedlings continued to fulfil their early promise, the average yields per acre of these, together with the main commercial varieties, being as follows:

Wellington's Triple X	..	..	..	..	4.5 tons.
" Double X	..	..	..	..	3.9 tons.
" Single X	..	..	..	..	3.6 tons.
Baldwin	..	..	..	..	} 3.3 tons.
Seabrooks	..	..	..	..	
French	..	..	..	..	
Goliath	..	..	..	..	
Boskoop	..	..	..	..	2.7 tons.
	..	..	..	..	2.5 tons.

The fruit obtained from these seedlings was large and of good appearance. Unfortunately it was not possible to obtain any strict market comparison with other varieties, as during most of the time they were being picked, the weather was wet and stormy and much of the fruit had to be marketed in a damp condition.

Prices ranged from 5½d. to 8d. a lb. except where the fruit was wet when it dropped as low as 4d. Prices were highest at the start, gradually falling as the season advanced. The gross return came to £385 or an average of 6d. a lb.

Twelve cwts. of fruit was obtained from the new seedling crosses being tested out on Upper Grub and 6 cwts. from the "Big Bud." Spraying Trial Plot in Great East. These brought in £36 and £15 respectively.

All the fruit with the exception of that sold on contract was marketed in 6 lb. chips.

Cherries. (Area of Acid Cherries under cultivation—¼ of an acre of 9 to 11 year old Morellos, planted at 12 by 12 feet, ½ an acre of 6 year old Morellos, ⅔ of an acre of 5 year old Kentish Red and ⅓ of an acre of Carnation and young Morellos, all at 15 by 15 feet.)

The Morello crop at 1¼ tons was very much less than that of last season. In the case of the 9 to 11 year old trees every alternate tree was cut back hard in the spring to test the effect of dehorning on an overcrowded plantation, whilst the remainder only cropped comparatively lightly after their exceptionally heavy crop of the previous year. The 6 year old trees however gave a very fair yield.

The fruit, which was of excellent quality, was marketed in 6 lb. chips, little or no grading being necessary, and brought in £86 gross or an average of 7½d. a lb.

The Kentish Red Cherries gave their first crop amounting to 7 cwts. These averaged 6d. a lb. and brought in some £20.

With the exception of a tree here and there in the variety collection, none of the sweet cherries are yet in bearing.

Plums. (Area under cultivation—2½ acres of 11 year, 3 acres of 10 year, 2 acres of 7 year, 2½ acres of 4 year, and ½ an acre of 17 year old miscellaneous trees.)

The plum crop was on the whole distinctly good. On the 11 year old stock trial plot, which failed last year, most varieties did well, Victorias, Czars, Pershore Egg, Purple Egg and Giant Prune, all cropping heavily, whilst Denniston's Gage and Belle de Louvain gave very fair yields of good sized fruit. On the 10 year old stock trial plot, where the yield was good last year, the crop was inclined to be patchy but still good in the main. On the two younger plots, Czars, Victorias and Pershore Egg cropped well for their age. Damsons on the other hand were light.

For the first time since 1927 the Myrobolans were badly cut by the frost, with the result that the average yield of the twenty-six trees referred to in last year's Report was only 24 lbs. per tree, the average price per lb. being 5·2d. and the gross return per tree 10s. 5d., against £2 5s. 6d.

The total crop amounted to 26½ tons, mainly Victorias and Czars, which contributed 7 and 6 tons respectively.

For the second year in succession the crop in the country as a whole was short and prices good, only a few half-sieves of inferior fruit fetching as low as 4s., while selected Victorias, Gage Plums, Warwickshire Drooper and various Damsons touched as much as 6s. 6d., and 7s. a 12 lb. clip. Gross receipts amounted to £900, being an average of 7s. 6d. a half-sieve.

Over 12 tons of fruit were marketed under the National Mark which was applied to certain varieties of plums for the first time. In the case of Czars, Rivers Early, Pershore Egg, Purple Egg and Belle de Louvain it was found possible to market 80 per cent or more of the crop under the scheme, but with Victorias, for which the standard is considerably higher, the proportion was only 34 per cent.

All fruit was graded, the National Mark "Selected" grade being further subdivided into either two or three size grades, but experience seemed to show that two were quite sufficient.

Two-thirds of the crop was marketed in 12 lb. chips and one-third in half-sieves.

Pears. (Area under cultivation—4 acres of trees from 6 to 13 years old, and consisting of a number of different varieties.)

The crop, though larger than last year, was again light, no variety yielding any very appreciable amount of fruit. Strong winds were experienced early in September which caused a heavy fruit fall, principally in the case of Congres and Conference. In all some 350 bushels (including 40 of dropped fruit) were marketed, for which a gross return of approximately £150 was received.

Apples. (Area under cultivation—23 acres, consisting of many different varieties, of which 7 acres have not yet come into cropping. Main varieties, Bramley's Seedling 2½ acres, Lane's 2¾ acres, and Worcesters 2½ acres, mainly 13 year planted trees at 15 by 15.)

The total apple crop amounted to approximately 5,000 bushels, an increase of 50 per cent on the previous year's total, of which some 800 bushels, almost entirely Bramleys, still remain to be marketed. It is estimated that when this has been done the gross receipts will be in the neighbourhood of £1,750.

Of the main varieties grown, Bramleys cropped heavily, except on the plot which was grassed down in 1930. Here the crop was inclined to be patchy.

Lane's Prince Albert on one plot cropped well, whereas on the neighbouring one the crop was light. Worcesters were definitely in their off year. The actual yields were approximately as follows :

Bramley's Seedling	..	..	..	..	1,300 bushels.
Lane's Prince Albert	..	..	..	..	1,000 „
Worcester Pearmain	..	..	..	..	500 „

Other varieties which cropped well were Grenadiers (280 bushels), Early Victoria (270 bushels), Belle de Boskoop (280 bushels), and Cox's Orange (140 bushels).

In the case of Bramley's Seedling, Cox's Orange, Gladstone, James Grieve, Grenadier, Bismarck, Early Victoria and other Codlin varieties, the fruits were thinned to singles, except in the case of some of the younger Grenadiers, where the clusters were left in doubles.

As has been the practice ever since the inauguration of the Scheme, where possible, fruit was graded and packed to National Mark standards, some 2,300 bushels being treated in this way, but it has to be remembered that there are a considerable number of varieties grown here which are not at present eligible for marketing under that scheme. The figure given above includes some 700 bushels of Bramleys which still remain to be marketed.

In continuation of the table given last year, the following are the percentages of the 1932 Worcester crop under the different quality grades :

	1932.		Previous 3 years' average.
	Bushels.	%	
"Extra Fancy"	117	24	16
"Fancy"	218	44	45
"C" grade Standard	117	23	24
Smalls (under 2" size, all quality grades) ..	28	6	7
Culls	13	3	7
Total	493		

From this it will be seen that the figures approximate very closely to the previous three years' average, except that the proportion of the "Extra Fancy" is somewhat higher and that of the Culls somewhat lower.

An analysis is not given in the case of the Bramley crop, as the greater part of the fruit, though graded, has not yet been packed or marketed and in consequence the figures would be rather in the nature of an estimate.

The variety collections of apples both on the Cordons and in the field gave good crops in the main. Whereas the Cordons on No. IX stock, which have been grown on old hop land, but since grassed down in between the rows, gave fruits of good size and colour, that from the field was generally small and poor coloured. This is probably accounted for by the fact that the trees from which they come are worked on Doucin Amélioré (Malling No. V stock). This was done before the bad qualities of this stock were known.

It had been the intention to start picking the Early Victoria crop about 25th July, but heavy rains about this time so much interfered with soft fruit picking that no labour could be diverted until early August with the result that the best of the market was unfortunately lost. It seems essential to get this variety off early if good prices are to be obtained.

The 7 and 8 year old trees of Belle de Boskoop cropped well. After last year's experience steps were taken as far as possible to prevent scalding by leaving the apples under the trees for some days after picking and by wrapping them in oiled wraps before being stored. Even so signs of scald began to appear by the middle of February. This apple, though of good edible quality and popular for dessert on the Continent, does not as yet sell well for that purpose over here and only seems at present to have a market as a culinary variety.

As stated previously, prices were generally lower than in 1931. "Extra Fancy" and "Fancy" Worcesters in boxes and half-sieves fetched from 9s. to 16s. a bushel, and "C" grade in half-sieves from 7s. to 10s. according to size, "Extra Fancy" and "Fancy" Cox 4s. 6d. to 5s. in trays, 18s. to 23s. a bushel in boxes and half-sieves, and "C" grade standard in half-sieves 14s. to 21s. Lanes before Christmas made 4s. to 7s. and Bramleys 3s. 6d. to 7s. 6d. a bushel for "C" grade standard and above. Cold stored Bramleys, however, are now (the middle of March) making from 6s. to 10s. 6d. a bushel.

The double worked Blenheims gave their first crop amounting to some 60 bushels of good coloured and well finished fruit. A large proportion of these were marketed in trays at 3s. to 3s. 6d. a tray.

A.C.P.

HOPS.

The cool and rainy conditions which prevailed throughout May were very favourable for the spread of the Downy Mildew and in consequence the "spike" form of the disease was extremely severe; it was necessary to go over the gardens weekly to keep the spikes in check. However, the dry weather in June checked the spread of the disease, but thundery conditions during the second half of July caused a fresh outbreak on laterals amongst the burr, the first spraying was given on 27th to 30th July and prevented the spread among the burr. The second spraying was given on 10th to 13th August. A satisfactory control of the disease on the cones was secured on the bulk of the varieties, but it was clear that the best dates for spraying to secure full protection vary with the season of the variety and that in a mixed garden such as ours with three hundred seedlings of varying seasons growing together, it is difficult to obtain a complete control on all varieties. Yields were considerably higher than in 1931, and the quality of the crop was also superior, the increased crop being due to the heavier dry weights obtained and not to any large increase in the number of bushels of green hops.

The remaining half acre of Tutshams, nine rows of seedlings, and a half acre of ground under a trial of early and midseason hops (which have now been superseded by better varieties) have been grubbed, and the latter half acre is being planted up with the late seedling OV7, and will be utilized for cultural trials. The total growth amounted to nearly 6 tons, compared with $3\frac{1}{2}$ tons in the previous season. Although at the time of writing complete returns are not available, prices are somewhat higher than those obtained for the 1931 crop; as we still have only small quantities of any one variety to market the prices given here can only give a general indication of value. The Manitoba Seedling C9a, realized £10 10s. per cwt., whilst an early seedling X35 made £10, whilst Bramleys and Tutshams made £9 10s. and £9 respectively. A large number of seedlings have been sold for £8 10s. and £8 per cwt. The produce ($9\frac{1}{2}$ pockets) of the half acre devoted to the early seedling L21 (Tolhurst $\times$ English male) realized £6 10s. per cwt. F.H.B.

APPENDIX.

ROUTINE SPRAYING PROGRAMME, 1932.

Winter.

AGAINST EGGS OF APHIS AND APPLE SUCKER.

January Tar Distillate 5 to 6%

Apples, Plums, Pears, Cherries, Black
and Red Currants and Gooseberries.

AGAINST CAPSID EGGS.

18th and 19th

Apples (applied to two plantations).

February .. Winter Petroleum 7½%

Spring and Summer.

AGAINST SCAB, CATERPILLAR AND RED SPIDER.

6th to 13th May .. (a) *Pre-blossom "Pink bud" stage.**Apples*—all varieties.

Lime-sulphur .. 3½ galls.
 Water .. 96½ galls.
 Arsenate Paste .. 4 lbs.
 Gelatine .. 1 lb.

2nd to 7th June .. (b) *1st Post-blossom.**Apples*, excluding the following sulphur-shy varieties: Lane's Prince Albert, Rival, Beauty of Bath, Belle de Boskoop, Stirling Castle and St. Cecilia.

Lime-sulphur .. 1 gall.
 Water .. 99 galls.
 Arsenate Paste .. 4 lbs.
 Gelatine .. 1 lb.

15th to 26th June (c) *2nd Post-blossom.**Apples*, as for 1st post-blossom.

Lime-sulphur .. 1 gall.
 Water .. 99 galls.
 Gelatine .. 1 lb.

6th and 7th July .. (d) *3rd Post-blossom.**Apples*, as for 1st and 2nd post-blossom.

Lime-sulphur .. 1 gall.
 Water .. 99 galls.
 Gelatine .. 1 lb.
 Nicotine .. 6 ozs.

AGAINST CAPSID.

17th to 31st May Nicotine .. 8 ozs.
 Soft Soap .. 8 lbs.
 Water .. 100 galls.

Apples, where necessary. Where winter Petroleum had not been applied.

AGAINST RED SPIDER.

During period May Summer Petroleum 1 gall.
 to July (when necessary) Water .. 99 galls.
 Nicotine (for capsid) 8 ozs.

Apples, sulphur-shy varieties, i.e. Lane's Prince Albert, Stirling Castle and Newton Wonder.

AGAINST SCAB, CATERPILLAR AND RED SPIDER.

20th and 21st April *Pre-blossom "White bud" stage*
 Lime-sulphur .. 3½ galls.
 Water .. 96½ galls.
 Arsenate Paste .. 4 lbs.
 Gelatine .. 1 lb.

Pears (applied to two plantations) one plantation with gooseberries as under crop—arsenate paste omitted.

AGAINST SCAB.

1st June *Post-blossom.*
 Lime-sulphur .. 1 gall.
 Water .. 99 galls.
 Gelatine .. 1 lb.

Pears (two plantations as above).

6th June Copper Sulphate 8 lbs.
 Lump Lime .. 8 lbs.
 Water .. 100 galls.

Pears (one plantation where gooseberries under crop).

AGAINST RED SPIDER AND APHIS.

1st June	..	..	Lime-sulphur	..	1 gall.
			Water	..	99 galls.
			Nicotine	..	6 ozs.
			Gelatine	..	1 lb.

Plums—all varieties.

AGAINST BIG BUD MITE.

19th and 20th April		<i>Pre-blossom.</i>			
			Lime-sulphur	..	8 galls.
			Water	..	92 galls.

Black Currants.

AGAINST BEETLE.

17th and 18th June		<i>During blossoming (twice).</i>			
and			Proprietary Derris		
27th and 28th June			powder	..	2 lbs.
			Soft Soap	..	5 lbs.
			Water	..	100 galls.

Raspberries.

AGAINST TARSONEMID MITE AND RED SPIDER.

7th and 8th October			Lime-sulphur	..	3 galls.
			Water	..	97 galls.
			Gelatine	..	1 lb.

Strawberries.

AGAINST APHIS.

26th and 30th June			Nicotine	..	6 ozs.
and			Soft Soap	..	4 lbs.
8th and 9th July	..		Water	..	100 galls.

Hops.

AGAINST DOWNY MILDEW AND APHIS.

27th to 30th July			Copper Sulphate	10 lbs.	
and			Lump lime	..	10 lbs.
10th and 11th August			Water	..	100 galls.

Hops.

Section II

GENERAL REVIEW OF RESEARCH WORK

POMOLOGY

In Relation to Tree Fruits

(a) ROOTSTOCK INVESTIGATIONS.

APPLES.

Observations are continuing on the influence of rootstock on the wide series of varieties under trial.

A further plot of Bramley's Seedling and Worcester Pearmain has been grassed down ; but the immediate effect of the grass this season has not been so marked as in a previous instance.

The earlier plots to be grassed down have this year shown unmistakable signs of nitrogen deficiency and an attempt to alleviate this by a dressing of 5 cwt. per acre nitro chalk has not proved wholly successful.

However the effect of grassing on the vigour of Bramley's Seedling, especially on the vigorous rootstocks at this stage in their development, has not been sufficient to solve the problem of overcrowding on these plots ; and the question of thinning becomes of immediate importance.

(R.G.H. and J.A.)

(b) ANALYSIS OF ROOTSTOCK INFLUENCE, INCLUDING THE RECIPROCAL EFFECT OF SCION UPON ROOT.

It has already been reported (1930) that root-systems of two year old trees retained their distinctive characters when either stem-worked or piece-root-worked with Grenadier or Beauty of Bath. A further report has now been published (E52) of field observations of similar trees three and four years old. Stock influence on scion, such as duration and length of stem growth, early blossom bud formation, percentage of blossom setting and amount and quality of fruit are exhibited whether the trees are stem-worked or root-worked. A series of these trees has been planted out for continued observation.

Trees of Lane's Prince Albert, stem-worked and root-worked on vegetatively raised stocks Nos. II, IX and XII, and on seedlings have also been planted out half with the unions above ground level and half with the unions below ground level, when special precautions are taken to prevent scion rooting. These will be grown as bushes and full records will be taken in order to study their behaviour in maturity.

(R.G.H. and J.A.)

In relation to this work a study of the comparative anatomy of the roots and stock stems of a series of bench-grafted Lane's Prince Albert apple trees on four different stocks (Nos. II, IX, XII and seedlings) has been initiated. A series of sections of roots, some of which had been growing above ground and some below, and also of stock stems above and below ground, have been prepared and examined microscopically. This work is being continued on further sets of trees.

(A.B.B. and B.C.)

PEARS.

The pears on quince rootstocks A, B and C have borne good crops during the past season, the first considerable crop from Doyenne du Comice having been harvested. With regard to the other incompatible varieties of quince used as rootstocks, it has been noticeable that where trees originally on these stocks are still alive, most have proved to have established themselves on their own roots, whereas those which have not are now rapidly deteriorating.

The trial of Dr. Jules Guyot on clonal races of "Free" (*P. communis*) stock has during this season produced small crops of fruit and marked differences between the various stocks are apparent. The two stocks which are outstanding in this respect are among those which have already indicated early cropping potentialities in their blossom production. It is worthy of note that the trees on these two rootstocks have been up to the present among the most vigorous in the series.

PLUMS.

The series of trees in which three varieties on their own roots are compared with trees on various rootstocks are now yielding interesting results. Whereas with one variety (Victoria) the "own root" trees are considerably stronger than those on any rootstock, in the other two cases Cambridge gage and Pershore, those on Myrobolan B. are still making the largest trees. (See below—Propagation.) (R.G.H. and J.A.)

PEACHES.

The trained trees failed to crop during the past season due, largely, to the adverse weather conditions experienced at blossoming time and to the lack of shelter for the trees.

Clonal races of "common" peach are being raised from layers for testing alongside various plum rootstocks in the nursery as stocks become available. (R.J.G.)

CHERRIES.

Acid Cherry (Prunus cerasus) scions.

A report is in preparation on the results of the trial of Mahaleb, Mazzard, and Acid cherry stocks with Morello scions.

Sweet Cherry (P. avium) scions.

Of the three varieties in the trial of standard trees, one, Bigarreau de Schrecken has this year been considerably affected by bacterial die back. The other two varieties, Early Rivers and Turkey Heart, are not affected enough to reduce the value of the trial appreciably.

The overseas acid cherry stocks, "Stockton Morello" from California, and "Kentish" from New Zealand, are being prepared for propagation as rapidly as possible. As it will be some years before material is available for working, a preliminary trial is being prepared with suckers from two acid cherry stocks in the oldest Morello plantation. (N.H.G.)

PROPAGATION.

The search for new rootstocks continues and these are being tested for ease of propagation and nursery performance. Thirty groups of seedling *Prunus*, presented by the John Innes Horticultural Institution and collected from the Caucasus, have been budded with the commercial variety Czar to test compatibility; selections of these will be further tested for ease of vegetative propagation.

The experiments on the propagation of fruit tree rootstocks by means of hardwood cuttings and root cuttings have been continued. (R.J.G.)

A very intensive experiment in the propagation of Plum rootstocks from root cuttings carried out during the season in collaboration with Mr. R. C. Palmer has yielded valuable results.

Of the two varieties under trial, Pershore Egg was a complete failure, while varying degrees of success were obtained with Common Mussel. In this connection the importance of *early* planting of *large* cuttings was clearly demonstrated. A joint report is in preparation. (See also Statistics.) (R.C.P.)

The preparation of a series of plum trees having frameworks of a variety resistant to bacterial canker has been continued. Some twelve-year-old trees of the resistant variety Utility, have been successfully "overworked" or "framework-grafted" on the Tasmanian method with the varieties Czar and Victoria and records of cropping and the incidence of disease will be taken.

Three varieties of apple "stem-builders" from Germany have been used in a nursery trial and have now made one year's growth from the bud. They will be worked with second scions of commercial English varieties.

Thirty-two twelve-year-old trees of Stirling Castle have in a preliminary attempt been "framework budded" with Worcester Pearmain, but with little success. Further methods will be used next season.

A series of nursery technique trials have been inaugurated to test the effect of using rubber budding-strips and the desirability or otherwise of the removal of wood from the bud shield of apples. Further technique trials will be undertaken as opportunity offers. (R.J.G.)

(c) ROOT DEVELOPMENT INVESTIGATIONS.

As a result of the exchange of workers arranged between Summerland, B.C. and East Malling, the root study work has been continued at East Malling and the projected comparative study of fruit tree root-systems under conditions of artificial irrigation in British Columbia has been carried out. A number of irrigated trees were excavated, and an improved type of root observation trench was installed at the Dominion Experimental Station, Summerland, B.C. Three similar observation trenches were installed at East Malling at the same time. Thus a similar technique is being used under these widely differing conditions.

In these trenches it is found possible to observe the root growth by means of glass windows supported against the soil (and normally protected from light). Information which is being obtained includes period, rate and position of new root growth and suberization, and the reaction of the roots to various soil and climatic conditions. Photographs and photo-micrographs are also being taken. Root troubles are responsible for much loss and damage to fruit in British Columbia, and this method of direct observation seems likely to give valuable results. The Research workers of the Summerland Experimental Station are now continuing this work at their station.

The possibility of avoiding these root troubles by the use of resistant rootstocks has been considered. In this connection a tour of the Okanagan Valley was made and roots were collected from trees of outstanding performance (on unknown seedling stocks) to start new vegetatively propagated clonal races of rootstocks.

In the root excavation work at Summerland a number of young trees on seedling stocks were studied, and in some cases compared with the same varieties on Malling clonal stocks. The seedling root-systems were found to differ considerably among themselves, and were markedly different from the root systems of clonal stocks. Two larger trees were excavated, one being normal, and the other suffering from "collar rot".

The root observation studies at East Malling have been extended. Records of period and rate of root growth throughout the year have been obtained and correlated with shoot growth, seasonal changes and soil temperature. The information thus obtained is of great interest in connection with the question of time of application for manures. The rootstocks now being studied by observation trenches against mature trees are Numbers I, IX and XVI, covering the range from very dwarfing to very vigorous. The stocks in the observation boxes now in their second year are Numbers I, II and XIII.

The question of possible effect of light on the roots during examination is being studied.

The problem of measurement of soil moisture conditions in the root area of the tree has received attention. A soil moisture meter giving direct reading, but over a limited range, has been developed, and a preliminary report on this is in course of preparation. (W.S.R.)

(d) INVESTIGATIONS IN BIENNIAL BEARING.

These have been initiated with apple trees and, in an attempt to analyse the causes, the removal of part or all of the fruit buds, at different stages of development, from either the whole or parts of trees already exhibiting the habit, is being carried out. Records from the rootstock, pruning, fruit thinning and manurial field trials are also being analysed from this point of view. (A.C.P. and N.H.G.)

(e) DOUBLE-WORKING OF FRUIT TREES.

Further data on the influence of intermediate varieties in double-worked apple and pear trees on cropping and fruit quality have this year been collected. There are indications that the intermediate may directly or indirectly influence the susceptibility of the fruit to scab.

A nursery trial of double-worked pear trees on some of the intermediate varieties showing promise in the field trials is now in the maiden stage, the stocks being Angers quince and a layered "free" pear. (N.H.G.)

(f) INVESTIGATIONS INTO THE NON-SETTING OF THE BLOSSOM OF CERTAIN VARIETIES OF PEARS.

A concerted attack on this problem, from the points of view of cross-pollination, stem ringing, pruning, and double-working has been begun this year. Cross-pollination is referred to under Fruit breeding.

Stem ringing was carried out with trees of Pitmaston Duchess just before the blossom opened. No effect was observed as a result of this operation on the setting of the blossom in the current year.

Pruning, whether by partial or severe dehorning, or by drastic spur thinning, somewhat reduced the crop of fruit, but appears to have increased the set of the blossoms remaining. The varieties concerned were Doyenne du Comice and Marie Louise.

Some trees of Doyenne du Comice have had certain branches top-worked high up with scions of Glou Morceau. Although it has been claimed that an improved set of blossom has sometimes been obtained by this process in the first year, the results in this case are so far inconclusive. (N.H.G., N.B.B. and H.M.T.)

(g) PRUNING.

APPLES.

The first year's results in the trial of dehorning and spur thinning are encouraging enough to warrant their continuance and possibly extension. Both processes have materially increased fruit size. Observations are being extended to their effect on fruit bud formation and regularity of bearing. (N.H.G.)

PEARS.

Further crops have been harvested from the older series of pears under differential pruning treatments. The younger series which is now four years old, will come under different winter pruning treatments for the first time during the coming season. (J.A.)

An experiment on the effect of three different methods of pruning on growth and cropping of nine varieties of pear grown as cordons on Quince A was commenced this year. The trees were planted out as maidens in February. The pruning methods under trial are winter leader pruning combined with winter spur-pruning, winter leader-pruning combined with hard summer spurring, and late Spring leader-pruning combined with winter spurring. (N.B.B.)

CHERRIES.

The oldest Morello plantation having become somewhat overcrowded, alternate trees have been severely dehorned. The crop of the dehorned trees, as was to be expected, has in the first year been negligible. Growth, however, has been good, and there is every reason to think that this method will be a satisfactory solution of the overcrowding problem. Observations are being made on quality as well as quantity of fruit. (N.H.G.)

(h) FRUIT THINNING.

PLUMS.

Owing to the variable crop no opportunity occurred for carrying out the further experiments referred to in the last report. This, however will be done as soon as opportunity offers. (A.C.P.)

APPLES.

The experiment started in 1927 on young trees of dessert varieties has been continued. Other experiments have been commenced in two cooking varieties—"Grenadier" and "Early Victoria". (A.C.P.)

(j) MANURING.

APPLES.

The outstanding point of interest during the past season has been the very marked and comparatively rapid response to potash applications of the trees on both the apple manurial trials in progress.

The twelve-year-old Bramley's Seedling and Worcester Pearmain trees, previously unmanured for ten years, have in two seasons responded to a marked extent in growth, size and quality of fruit, to heavy applications of Sulphate of Potash.

In the younger and more extensive trial of Cox's Orange Pippin and Beauty of Bath on four representative rootstocks, now two years in situ, the previous "running-out" of the land by growing thereon successive crops of wheat and oats without manuring, has resulted in abundant leaf scorch in the present season.

This trouble, however, has been so much less as to be of little importance on the plots receiving potash, with the result that these plots have made much more growth.

Further indications of a varying response to manuring by trees on different rootstocks are bearing out the findings on the earlier trial.

(R.G.H., J.A., T.N.H. and W.A.B.)

(k) VARIETY COLLECTIONS AND TRIALS.

The observations made on the apple collections over a number of years have been reviewed during the year.

Most of those varieties which are worthy of retention for further trial, breeding purposes, or on account of particular peculiarities, have been worked on very dwarfing apple stock (IX) and transferred to the cordon "Library".

About eighty varieties in the original apple collection are now eleven years old. It is proposed to overwork such of those varieties as have proved poor croppers or are otherwise unsuitable.

Records are being continued on the cordon trees.

(H.C.C.)

(l) FRUIT BREEDING.

ROOTSTOCKS.

The work of raising seedling apple rootstocks from crosses between the Malling series of "Paradise" stocks and varieties immune to Woolly Aphis, with the object of combining immunity to this pest with the desirable qualities of the "Paradise" series, has been continued. The closest collaboration has been maintained with the John Innes Horticultural Institution, while the Entomological Section have again been responsible for the testing of the seedlings. During the past season approximately 300 seedlings were raised at East Malling, and approximately 300 at John Innes Horticultural Institution and passed through the infection test, while about 1,000 seedlings should be available during the coming season. In addition to direct crosses between various members of the "Paradise" series and Northern Spy, certain of the immune seedlings have been crossed among themselves and back-crossed on to Northern Spy. Records of wood growth, blossoms and fruits are being taken upon one series of selected immune rootstocks budded with Lane's Prince Albert and additional series are in course of preparation for further, more extensive trials.

A number of families of seedlings from crosses between the "Paradise" stocks, stooled during the winter of 1931-32, gave their first crop of stocks during the present winter. Rooting was, in most cases, good, and a number of the more promising individuals have been selected for further propagation. Careful records upon these seedlings have been kept throughout and some useful information has been obtained on their botany and genetics. The data will form the subject of a paper, now in course of preparation. A few of these families will be worked, in their entirety, with Lane's Prince Albert to provide information on the inheritance of their influence on the scion. A number of further families were raised during the past season. Records have been continued on trees of Lane's Prince Albert worked on selected rootstocks of VIII $\times$ IX raised at Merton in 1924. Seedlings of apples and pears, raised from seed collected in Russia and the Caucasus, will be planted out during the present winter to test their worth as possible new rootstocks.

A number of *Prunus divaricata* varieties obtained from Asia Minor and the Caucasus, through the John Innes Horticultural Institution, were budded with Czar plum during the present autumn to see how far they would prove compatible with this

variety and of use as future plum rootstocks. A number of Quince seedlings received as seed from Russia have been planted out for testing as possible improved rootstocks for pears.

SCION VARIETIES AND SHORTENING OF THE " JUVENILE PERIOD ".

During the past year several crosses between Apple varieties were made with the object of producing new varieties of good quality and extended season. A few crosses were also designed to shed light on the genetics of fruit colour in the apple. A large number of seedlings worked on rootstocks IX and XII were planted out in cordon rows during the past winter, as a preliminary trial, to test the effect of rootstocks in hastening the fruiting of seedling apples. A series of twelve seedlings, layered during the past winter to provide material for a larger trial, have given their first crop of layers during the present season. They will be left for one more season before the required material is available from them. A seventeen-year-old tree of Lane's Prince Albert was over-worked with scions from five seedlings to see how far the adult " mother " will induce earlier fruiting in the scions. All the grafts were successful and have made very vigorous growth during the past season. About fifty seedlings, now two years old, are being grown in pots in the greenhouse to see how far the restriction of root development due to pot culture may hasten fruiting. A few crosses between pear varieties, designed to produce new varieties of high quality and extended season, have been made and a number of seedlings, raised during 1931, are ready for planting out, as cordons, this winter. Several families of apple and pear seedlings, obtained as seed from Russia, will be planted out in cordon rows during this winter for testing as possible new varieties.

In an endeavour to improve the fertility of the Utility plum, flowers were pollinated with pollen from six varieties of plum. Considerable differences were found to exist in the compatibility of the different varieties. During the coming season the self and cross fertility of the different forms of St. Julien and Black Damas will be tested in elaboration of the cytological work of Moffett (Merton) on these forms of *Prunus*.

A number of trees of Doyenne du Comice on three types of Quince, subjected to differential treatments, were self-pollinated and pollinated with Glou Morceau in an attempt to determine the cause underlying the infertility of that variety. Moderate sets of fruit were obtained by the use of pollen of Glou Morceau, but Comice was found to be almost completely self-sterile under the conditions of this experiment. (See f.)

(H.M.T.)

(m) POMOLOGICAL ASPECTS OF SPRAYING.

In connection with the Fungicide Trials (see Mycology and Bacteriology Section) it has been found that sulphur sprays and dusts may cause injury (fruit-drop) on Cox's Orange Pippin in certain seasons. This variety is also copper-" shy ". General observations have shown that several other varieties are sensitive to spray-injury. It is hoped that data will be forthcoming on the relationship between spray-injury and such factors as manuring, rootstock and weather conditions. (M.H.M.)

(n) MARKETING PROBLEMS.

The influence of such factors as variety, stock, pruning, thinning, cultural and manurial conditions, as heretofore is being carefully watched in relation to market value over a series of years. (A.C.P.)

I. ARTIFICIAL IRRIGATION OF APPLE TREES.

The early drought of 1932 offered an opportunity for testing out any possible effects of the partial irrigation methods, such as are used in certain localities overseas where rainfall may be a limiting factor to fruit development.

In this area of light spring and summer rainfall such methods might especially prove of value in increasing the size of green cooking apples required early upon the market. In June, a row of sixteen trees of Early Victoria, 18 years old, with a heavy set of fruit, was irrigated by means of three plough furrows drawn out on either side of the trees. Water, equivalent to 3 ins. of rain (67,866 gallons per acre) was regulated by stop-cocks down the furrows over a period of thirty hours. A control row of trees was untreated.

Soil moistures were determined on samples taken before and after irrigation. These showed an increase from 1 to 4 per cent of moisture in the top 9 ins. of soil and a 10 per cent increase in the second 9 ins. as a result of irrigation.

Examination of the weight and size of fruit has revealed no increase attributable to irrigation.

Unfortunately the trees are a very variable series on seedling roots though their individual histories were known for many years previous. The experiment will be elaborated as opportunity offers. (R.G.H., J.A. and A.C.P.)

(o) KENT FRUIT SOIL SURVEY.

The Report on the Survey of the Lower Greensand Formation has been completed and after its acceptance by the Ministry is now being prepared for the press.

Meanwhile a Survey of a part of the Hastings Beds formation, also known as the High Weald, has been undertaken in conjunction with Wye College. The new area includes the parishes of Cranbrook, Goudhurst, Horsmonden and Brenchley. Some 1,500 acres of fruit have already been surveyed in detail, comprising fifty-five farms, of which the large majority had fruit areas of less than fifty acres. Of the total acreage surveyed, about one-tenth was found to be planted to bottom fruit, the remainder being mainly grass apple orchards originally planted in hops.

Profiting by the experience gained on the previous survey and by the comparatively straightforward nature of the soil series of the new area, both the pomological and soil sections have made rapid progress. Owing, moreover, to the extremely local distribution of the more important soil series, the correlation work has proved surprisingly easy and already, as a result of the joint investigations on soil and tree growth on the High Weald, valuable information is now available with regard to the selection of the most economic sites for fruit-planting in the area already surveyed.

(W.A.B. and N.B.B.)

(p) WALNUTS.

PROPAGATION.

Vegetative propagation of clonal rootstocks is proceeding by the layering method. In November, 1931 stools were opened up and the rooted layers cut off and counted, notes being taken on the type of rooting obtained in each case. As a result of these observations, in conjunction with those made in previous years, it was possible to eliminate several selections of *J. regia* and *J. nigra* which have shown poor rooting for the last three years. Hybrids between *J. regia* × *J. californica* and *J. nigra* × *J. californica* have consistently rooted more freely than any other selections. Some selections of *J. regia* and some hybrids have not yet given satisfactory rooting on the layers. This is probably due to the very strong growth made in the early life of the stools. There is reason to expect better rooting as the stools become older and the vigour of the annual shoots is reduced.

In 1932 all the layers were treated with a mixture of "spent" hops and sand in the first two earthings, to see whether freer rooting would result. On opening up the

stools in November, 1932, good roots were frequently found in association with "spent" hops. This treatment will be repeated in 1933.

Layers rooted three years ago are now developing vigorous growth comparable with seedlings. Therefore it seems probable that varieties of walnuts grafted on vegetatively raised rootstocks will be as vigorous as on seedling stocks, with the added advantage of having a known history.

This year 465 grafted plants of twelve varieties that have been chosen as most suitable for this country, were raised under glass. The fungus which caused heavy losses of the walnut grafts in 1930 and 1931 has been very largely controlled with 1 per cent formalin (see Mycology and Bacteriology Section), and 91 per cent success with first-class material was obtained in the spring.

Results this year indicate that June is the optimum month for summer grafting. Approximately the same number of grafts were put on in June, July and August, but 66 per cent of the successes were obtained from those put on in June.

A definite programme of patch-budding in the open has been carried out this season, with a view to finding a reliable method of outdoor propagation. Eight batches of buds were put on, roughly at fortnightly intervals, between 29th June and 19th October. Several methods were tried out in each batch. Some indication as to a successful technique has been obtained, but definite results will not be available until the surviving buds break next spring. A small autumn grafting trial was also carried out in the open during September and October. Here again results will not be available until next year.

VARIETIES.

At the end of 1931 two representatives of each of the sixty-four varieties collected at this Research Station were planted out in permanent positions at East Malling, and two at Kirdford in Sussex.

At the same time sets of twelve varieties were planted up in six localities across the South of England. In addition to these experimental sets of trees, small numbers of grafted walnut trees were distributed to growers.

The dates of leafing out of trees in the nursery were again recorded. The late-leaving habit of the twelve varieties selected for rapid propagation was confirmed.

The nutlets on older trees of named varieties growing at the Research Station were hand-pollinated and notes were made of the dimensions, sealing, flavour, etc., of the resulting nuts.

Enquiries for grafted trees have been received from South Africa, Denmark and Palestine.

OBSERVATIONS ON ESTABLISHED TREES.

In January, 1932, graftwood for spring grafting was collected from the trees selected at the Walnut Competition in 1929, and from the tree at Leeds Castle.

Data were collected, as in 1931, on the question of pollination of the established trees which have been selected as the best in the country. This information corresponded with that received last year.

In the summer, expeditions were made to the six sets of grafted trees that were planted up in the previous autumn. Records were taken on the growth and vigour of the same varieties under different conditions, and on the incidence of disease and character of the soil. Visits were also paid to the established trees selected at the Walnut Competition and notes made on the general condition of the trees and the probable crops.

OIL CONTENT DETERMINATION WORK.

In January, 1932, the percentages of oil and moisture were determined in samples of fresh nuts from the trees selected at the Walnut Competition in 1929. In every case the results were within 3 per cent of those obtained last season. Therefore the outstanding quality of nuts from these trees was maintained even after the very unfavourable season of 1931.

CURING AND STORAGE TRIALS.

Two samples of nuts were again used: (1) from one of the selected Competition trees, (2) an average sample from a local tree. After the heavy rainfall in 1931 both samples were below the average and about half the nuts had to be rejected on account of poor sealing and deficient shell formation.

After deshucking and washing, a portion of nuts from each sample was dried in the furnace room at 90° until no more moisture was lost.

As a result of experiments during the last two years it was possible to eliminate several methods of storing. By doubling the strength of the bleaching solution an attempt was made to increase the fungicidal properties of the bleached nuts. This method was unsuccessful as a white deposit appeared on the nuts when dry. The fungicidal properties of salt as a storage medium was much impaired when the nuts were dipped in a saturated solution of it instead of surrounded by it in bulk. A storage medium consisting of salt mixed with an efflorescent compound is being tried out. Promising results were obtained by the new method of dipping nuts in melted paraffin wax before storing. Experiments are being continued in this direction.

The possibility of storing walnuts under conditions similar to that of a private cellar are being investigated, in contrast to the comparatively simple problem of keeping them fresh and free from fungi in cold store.

DISEASES.

See Mycology and Bacteriology.

(J.B.H. and A.W.W.)

In Relation to the Small Fruits

(a) NOMENCLATURE, CLASSIFICATION AND VARIETY TRIALS.

A small number of bushes of the extensive range of varieties of black and red currant collected during the past twenty years is being maintained as a reference "library" as in the case of apples and pears. These are used for identification and breeding work as occasion arises.

The variety trials of black currants have been continued. The high cropping performance of the new seedlings raised at East Malling has been maintained and one of these is being planted together with Baldwin on a commercial scale during the coming season.

(R.G.H. and J.A.)

Work has begun on the classification of the mixed material grown under the group name of "loganberry".

Widely varying types have been identified in commercial "loganberry" plantations, including the form generally known as Phenomenal Berry. In accordance with the usual East Malling practice clonal races of some of these various forms are being raised and described and they will be compared pomologically.

There are indications that problems similar to that of the loganberry arise in the case of certain Blackberry varieties. This is being investigated in a similar manner.

The description and preliminary trial of about a dozen of the more important varieties of blackberries and dewberries are being continued. (A.B.B. and B.C.)

(b) PROPAGATION AND THE ESTABLISHMENT OF CLONAL RACES.

The schemes for the propagation for distribution through commercial channels of clonal races free from disease have been sufficiently advanced to show that the time and trouble involved are amply repaid by the results, and that growers readily respond to the opportunity offered of obtaining clean stock. (See also Mycology—Raspberry Mosaic.) (R.V.H.)

In a clone trial of strawberries all the runners from six selected parents have been planted out for trial. These six parents produced about 800 runners, whose whole life history has been recorded in detail. In two families twenty-three runners representative of different times of formation and different positions on the stolon have been used for the production of a second "generation" of plants (numbering some 3,700) on which similar detailed records have been taken.

All the rest of the plants are being recorded individually for vigour, blossoming, cropping and disease. The first year's records are already giving valuable information with regard to selection of runners. (W.S.R. and A.W.W.)

Work on the best methods of raising and transplanting some of the more important varieties of *Rubus* is being continued on clonal material. (A.B.B. and B.C.)

(c) PLANTING, TRAINING, PRUNING, ETC.

Further records have been obtained in a "uniformity" trial of strawberries, from which information of value in the planning of strawberry experiments is being gained.

Trials of "strain", time of planting and deblossoming of strawberries have been continued. Previous years' results showing the advantage of early autumn planting both in vigour and cropping are confirmed. The deblossoming trials showed that not only were the size of plant and production of runners increased by the removal of blossoms in the first year, but the crop in subsequent years was in most cases also materially increased. As the strain trials grow older new differences in vigour and cropping of the strains are appearing. The question of the virus disease "Yellow-edge" appears to be important in this connection, and is now being studied (see Mycology). (W.S.R.)

The trial of loganberries, in which training is being studied in relation to cropping and disease factors is yielding useful information. (A.B.B. and B.C.)

(d) MANURING.

The manurial trial of raspberries has been continued this season and a report has been issued (Esf21). The results indicate that, on this soil, with two varieties of very different habit, a proper balance between nitrogen and potash is the secret of the successful manuring of raspberries. Nitrogen may, up to a point, produce more cane by itself, but has never increased the crop except in the presence of potash. Of the kinds of potash fertilizer tried, Sulphate of Potash has, on the whole, proved superior to Kainit. (See also Statistics.) A further trial is in preparation. (T.N.H.)

(e) FRUIT BREEDING.

BLACK CURRANTS.

A plantation of 1,000 seedlings, consisting of selected seedlings from previous trials back crossed on to one parent variety, now five years old, gave their first appreciable crop during the past year. Many of them were markedly superior in cropping to Baldwin, growing under the same conditions, and about twenty have been selected and will be propagated for further trial. The seedlings are being retained for one further year.

A block of about 1,000 bushes, consisting of crosses between the main varieties, now two years old, are being recorded in conjunction with self pollinated families of the same varieties, in an attempt to follow out the inheritance of the botanical characters. Considerable progress has been made in elucidating these characters on a Mendelian basis.

Through the kindness of the Director of the John Innes Horticultural Institution, seed, pollen and young flowers of the black currant were subjected to X-ray treatment during the past spring, in an attempt to induce mutations of value in the improvement of varieties. A large number of seedlings have been raised from such treated material and will be closely studied during the coming years. A number of hybrid plants from crosses between *Ribes longiracemosum* and the black currant and between the gooseberry and the black currant have been raised. Some of these should fruit for the first time during the coming season. The trials of Wellington's selected seedlings have been continued. They were superior to Baldwin in their cropping performance here, during the past season. They are still being propagated in quantity and, "Triple X" in particular, is becoming increasingly popular among growers.

RED CURRANTS.

No further families of red currant seedlings were raised during the year but existing families are still being recorded for botanical and fruiting characters.

The collection of *Ribes* species has been augmented by several gifts during the year. The botany of these species is being closely studied.

STRAWBERRIES.

Two families of strawberry seedlings, raised during 1931, were planted out, for cropping, during the past spring. Considerable differences were observed in their susceptibility to "Yellow-edge" disease. In collaboration with the Mycology Section, it is proposed to make further crosses during the coming season, to elucidate if possible, the transmission and inheritance of this disease. (H.M.T.)

RASPBERRIES.

Some six of forty seedlings so far propagated have now been chosen for further propagation and trial.

Crosses have this year been made in the hope of producing varieties with high quality fruit and resistant to mosaic and other diseases. (N.H.G.)

(f) FRUIT THINNING.

GOOSEBERRIES.

Experiments have been commenced to test: (a) The relative value of thinning against no thinning. (b) The ultimate effect on the crop by removing in one case the larger and in another case the smaller berries as soon as they have attained a marketable size. (A.C.P.)

STATISTICS AND RECORDS

PLOT LAYOUT.

Now that a considerable amount is known concerning the variation to be expected in many fruit trees as grown at the present time, it has been possible to improve further the methods of plot layout which are being used. In this connection the growing needs of all Sections have afforded ample scope for the trial of newer and more economical methods.

Further, increasing demands from outside have given opportunities for the arrangement of plots on many different kinds of fruit plant.

Some of the trials laid down five years ago on soft fruits have now yielded their results and the technical experience gained is of great value.

In particular, an account has been given of two manurial trials of raspberries (Esf21). These trials have further emphasized the need for uniform material free from disease. They have also fully justified the methods used, which involved a proper distribution of replicated plots ; since in one case the differences connected with position were considerably greater than those due to the manurial effect. (See also Pomology.)

During the season a number of trials involving nursery practices have been planned. Of these, one, involving five separate factors, on the propagation of plum stocks from root cuttings, has been completed and a report on the statistical and pomological aspects is in preparation.

A series of simple manurial trials on growers' plantations has been planned in collaboration with Imperial Chemical Industries and Mr. W. G. Kent.

The records of a four year uniformity trial of strawberries have been examined and a report will be issued shortly.

TECHNIQUE OF RECORDING.

Investigations under this heading are continuing. Further sampling methods have been tried as opportunities have arisen.

A method for sampling the annual wood growth of spur pruned trees has been perfected ; and the problem of a similar method for use on trees, the leaders of which are not thinned annually, is being investigated. (T.N.H.)

PHYSIOLOGY

VEGETATIVE PROPAGATION.

(a) *Cuttings.*

Investigations on the conditions favouring rooting in hardwood cuttings have been continued in collaboration with the Propagation Section. For the third year in succession improved rooting of various plum stocks has been secured by placing a layer of sphagnum moss under the sand of the cutting bed. A layer of spent hops proved nearly as effective as one of sphagnum. An experiment on the combined effect of a layer of hops and of shading the cutting bed with muslin during the summer months has given favourable results. The percentage of rooted cuttings obtained was greater in the shaded bed than in the control which had a layer of hops. No improvement in rooting has been secured as yet by ringing or notching or by treatment of the cuttings with dormancy breaking substances such as ethylene chlorohydrin. Further work on the position of the basal cut and depth of planting has begun. (R.C.K. and M.C.V.)

(b) *Layers.*

Work has been commenced on the conditions influencing shoot and root production from layers, particularly of plum stocks.

Length, thickness, position on the parent layer and extent of etiolation are being observed in relation to the number, size and distribution of roots on layer shoots. Records of shoot and root growth of individual layer shoots will be taken through the summer season.

Further experiments have been prepared on the effect upon rooting of using different materials for mounding layered plants. (S.R.G.)

LEAF RELATIONS IN APPLE TREES.

The Distribution of Leaf Surface.

The data obtained in 1931 from an investigation of the leaf relations of two nine-year-old apple trees (Laxton's Superb) have been analysed and the results are being published in a paper at present in the press. One tree was on the dwarfing No. IX stock, the other on the more vigorous No. V, and they were in different fruiting conditions. The coefficients of variability in leaf number per growth and in leaf area show that the differences between the two trees could have been proved by counting the leaves on a random sample of a few hundred growths and by measuring the area of a few hundred random leaves. When the growths were grouped, however, according to their character, into categories such as "bearing" spurs, "non-bearing" spurs, primary shoots and secondary growths, the leaf relations were found to be widely different in various categories and much of the dissimilarity between the trees was found to arise from the proportions of growths in each category being different in the two trees. Thus the tree on No. IX had many more small-leaved bearing spurs and far fewer large-leaved primary shoots than that on No. V. In most categories, however, there were significant differences between the trees both in the number of leaves per growth and in the mean area of the leaf. To obtain an accurate estimate of the number, distribution and size of the leaves on a large tree by sampling it will be necessary, therefore, to sample from each

category of growth separately and to get some measure of the relative numbers of growths in each category. Work on the elaboration of a sampling technique that will fulfil these requirements is in progress. (M.C.V.)

Carbohydrate Relations.

Work on another aspect of leaf relations has been in progress this season, quantitative estimations have been begun of the carbohydrates in the leaves of an apple variety worked respectively on a dwarfing and on a very vigorous rootstock, to determine whether the efficiency of the leaves, as carbon fixing organs, is influenced by the rootstock upon which it has been worked.

The first season's work has been directed towards the adaptation of methods of carbohydrate analysis to apple leaf extracts and towards the determination of the appropriate size and nature of the samples to be taken. (E.R.L.)

GROWTH.

Seasonal Course of Root and Shoot Development in Apple Stocks.

The investigation into the course of growth during the year in the apple stock No. XIII, on which a preliminary report was published in 1931, was brought to a close in May when the trees had completed their second year's growth. The data will be analysed before further work on this line is initiated. (M.C.V.)

Effect of Scion on Root.

In the case of work previously reported which showed that the different rootstocks retain their varietal characters irrespective of the influence of scion variety, indications were obtained that the percentage of fibre was dependent in some degree upon the size of the root system. In collaboration with the Pomological Section, a batch of nearly 400 two-year-old trees of Grenadier exhibiting a wide range of size of root-system has been lifted and analysed to investigate this point more fully and the records are now being examined. (R.C.K.)

Records have been made of the leaf surface and stem lengths developed during the maiden year by the trees of the two apple varieties Beauty of Bath and Grenadier which were worked last year for an investigation of the causes of the marked difference in the relative amount of root produced by stocks worked respectively with these two varieties. The trees will be planted out and their stem and leaf development recorded for two or three years. They will then be lifted and the relative amounts of root, leaf and stem in trees of the two varieties determined. (M.C.V.)

BIOCHEMISTRY

MUTUAL INFLUENCE OF ROOTSTOCK AND SCION.

Ash Analysis.

This work has been carried on along the lines already indicated in previous reports.

Functions of the Elementary Constituents.

Methods have been evolved for introducing solutions directly into fruit trees. Not only may the leaves of a whole tree be almost completely permeated, but separate branches of a single tree may each be permeated with a different substance in solution without contamination by the substances introduced into other branches. Such branches may vary from current year's shoots to ones carrying one-tenth, or even more, of the foliage of a large tree. Because of their convenience dyes were used in most of the work on methods, but a few experiments in which potassium salts and sodium thiosulphate were used suggest that the general principles elucidated by the use of the selected dyes are applicable to such simple salts as artificial manures, but differences in detail are to be expected. The methods are sufficiently simple and inexpensive to be applicable to many practical problems in the plantation. A start is being made on some of these in commercial plantations.

An experiment carried out on three hundred rootstocks of Type III to test further the apparent effect of sodium thiosulphate on apple mildew failed to show any such effect (cf. last report). In a later experiment separate shoots, of a heavily infected tree, which had absorbed this substance, were for a time almost free from mildew, whereas an equal number of similar shoots which had absorbed water were heavily infected. The vigour of the former shoots was increased. Introduction of potassium nitrate into this same tree as a whole markedly increased its vigour.

Plum trees suffering from silver leaf or die back disease present special difficulties, but a number of heavily attacked trees as a result of treatment have had over 90 per cent of their foliage permeated.

Similar methods have been successful during the winter but absorption has been slower than in the summer.

This work is now being written up for publication.

(W.A.R.)

RESISTANCE OF DIFFERENT VARIETIES TO INSECT ATTACK.

(Jointly with Entomological Section.)

Causes of Resistance to Woolly Aphis.

This work, having reached the stage of requiring the almost undivided attention of at least one specialist worker it was temporarily discontinued, but the advent of a temporary worker will make possible its continuance during the coming summer.

(W.A.R. and A.M.M.)

Chemical Examination of Apple Bark.

This work must await suitable assistance.

(W.A.R.)

PLANT PATHOLOGY, MYCOLOGY AND BACTERIOLOGY

CROWN GALL.

The final observations have been taken in the experiment for investigating the relative susceptibility of apple stocks to crown gall, referred to in the last report. The results of this experiment confirm and amplify the results obtained previously (see 1930-31 report). The data are now being prepared for publication. (R.V.H.)

Preliminary experiments were carried out to test the effect of applications of sodium nitrate to apple trees artificially inoculated with the crown gall organism. The results were irregular, for not all inoculated trees developed galls. On the whole, however, the plants which received sodium nitrate produced more and larger galls than those plants which were not so treated. On some of the trees large galls developed but there was no evidence that the galls had any detrimental effect on the growth of the tree. (H.W.)

BROWN ROT DISEASES.

Leaf Infection by Sclerotinia cinerea.

Further trials have been made in investigating the manner of leaf infection by *Sclerotinia cinerea*, in relation to wilting of shoots of plum stocks in the layered nursery rows. "Stools" have been raised in pots, and leaves of shoots were inoculated immediately before they were "earthed-up". Infection, resulting in wilting of shoots, arose only where the inoculations were made on leaves which had been injured by puncturing.

Fruit Infection by Sclerotinia fructigena.

Severe outbreaks of brown rot occurred in 1931. In one instance apples were rotting in the market two or three days after they were picked. It was found that infection by *Sclerotinia fructigena* had started at the wounds left by picking the fruit away from their stalks. An account of this phenomenon has been published (C77). (H.W.)

BACTERIAL DISEASES OF FRUIT TREES.

Bacterial Canker of Plum Trees.

Data on the observations made on Bacterial Canker in plum trees since 1924 have been brought together and detailed descriptions of the symptoms of the disease have been published (C69, C72, C80, C81). The diseased trees are characterized by pale foliage, the leaves usually having upturned margins. On such trees a canker appears on the stem and the trees die during the summer. The organism causing the canker has been found to infect the leaves also, and occasionally the shoots and fruit. Its cultural characteristics have been studied in detail with special reference to its relation with *Pseudomonas prunicola* which causes a bacterial shoot wilt of plum trees.

The possible existence of the canker-producing organism in the soil has received consideration. Attempts to isolate the organism from the soil of plantations containing infected trees have so far been unsuccessful, and the direct inoculation of stems with soil has failed to produce infection. (H.W.)

With the object of ascertaining whether soil conditions have any effect on the pre-disposition of plum trees to Bacterial Canker two experiments have been planned.

(a) A series of pot cultures has been set up using a "complete nutrient" in sand, and various modifications of it. The trees have been subjected this year to the

different nutrient treatments ; next year it is proposed to continue the treatments and then to inoculate the trees with the Bacterial Canker organism. (F.H.B. and H.W.)

(b) A series of twenty-four plots have been planted up with young plum trees and submitted to various manurial treatments in random distribution. They will be kept under observation for the incidence of Bacterial Canker in relation to the different soil conditions, and artificially inoculated if necessary. (R.J.G. and H.W.)

Experiments to test whether it is possible to provide "frameworks" of resistant varieties on which to "overwork" the more valuable but susceptible varieties have been started. (See Pomology—Propagation.) (R.J.G.)

RASPBERRY MOSAIC DISEASE.

(i) *Analysis of Symptoms and Varietal Susceptibility.*

A further grafting experiment was carried out to analyse the symptoms of mosaic as they appear on the variety *Lloyd George* with reference to the two types of mosaic previously identified on the variety *Baumforth Seedling B*. This analysis was also extended to include the important varieties *Baumforth Seedling A.*, *Maclaren's Prolific* and *Preussen*. Compared with the results of previous experiments the percentage of successful grafts was outstandingly high. This in the first place was because the healthy plants used were in a very vigorous condition of growth due to the fact that they had been potted and grown for a complete season before the season of grafting. It was also due in part to an improved form and technique of bark-grafting which was used for the first time. (R.V.H.)

(ii) *Experiments in Commercial Control.*

The six special nurseries for producing *Lloyd George* cane free from mosaic infection (and incidentally from infection by the important *Cane-spot*, *Cane-blight* and *Spur-blight* diseases) which were planted in 1931 on selected farms in Kent and Sussex, have been rigorously inspected and rogued throughout the season and have produced their first crop of reliable mosaic-free cane. Each nursery was planted with 300 special mosaic-free canes raised on the parent Research Station Nursery. The labour and time involved in inspecting and roguing these nurseries has been very slight and their individual output this year (the first year of cane production) has been in the neighbourhood of 8,000 canes.

The demand for this cane and also for cane from the Research Station nurseries has greatly exceeded the supply. Applications have been received from all parts of the country, from Scotland, Ireland and from Canada. Thus a reliable scheme for the commercial control of raspberry mosaic (in *Lloyd George* in the first instance) is now actively proceeding. The attitude of growers to the opportunity provided is ample proof of the need for such schemes and there is every indication that they can be successfully and economically carried out. (R.V.H. and N.H.G.)

LOGANBERRY CANE SPOT.

A further spraying trial carried out during the year has indicated (i) that the addition of a spreader does not appreciably improve the action of a spray applied at the "delayed-dormant" stage and (ii) that the effectiveness of the control of the disease is greatly increased by the application of a spray at reduced strength at the "pre-blossom" stage. In addition a preliminary attempt was made to combine a fungicide for the control of cane-spot with the first application of derris against the loganberry beetle. The results of this trial were sufficiently encouraging to warrant elaboration next season. (R.V.H.)

DISEASES OF CULTIVATED BLACKBERRIES.

As time has permitted work has been continued (a) on the "Blue-blotch" disease (*Septocyta ramealis*) which is responsible for a considerable reduction of the cropping of certain varieties, and (b) on the so-called "Reversion" disease which is associated with the widespread degeneration of the "Cut-leaf" variety. Preliminary attempts to control the former disease by spraying with Bordeaux mixture have yielded promising results. (R.V.H.)

STRAWBERRY "YELLOW-EDGE" DISEASE.

A large-scale transmission experiment was carried out during the season employing the grafting technique previously determined and described in a paper published during the year (C71).

This experiment has finally confirmed the inferences drawn from the previous year's work, and has shown that although in the field Tarsonemid attack is commonly associated with the disease yet a rapid degeneration of normal vigorous *Royal Sovereign* plants can be brought about under strictly controlled conditions solely through the agency of a transmissible virus and quite independently of direct injury caused by mites or insects.

The diagnostic symptoms of this disease, which are of an extremely ill defined and transitory nature, have been determined in the case of several well-known varieties (*Royal Sovereign* in particular) and the name *Strawberry Yellow-edge* is proposed, in order to distinguish it from the analogous complex of diseases in America and from symptoms sometimes induced by direct mite injury.

Evidence is forthcoming that this disease occurs in widespread districts and is of very grave import to the strawberry grower. Further experiments have shown that its spread under natural conditions is rapid but local in nature, and that all runners taken from plants showing symptoms are themselves infected. Infected plants ultimately and invariably become sterile and die quite independently of any insect infestation which may be present or ensue. (R.V.H.)

The disease is closely associated with infestations of the *Tarsonemid Mite* and experiments to ascertain whether this mite is a vector are in progress. (See Report of Entomology Section.) (R.V.H. and A.M.M.)

Records taken during the year indicate that varieties differ considerably with regard to their susceptibility to the disease and further, that certain "strains" of a given variety may be more susceptible than others. There is also some evidence that in a given cross between two varieties, the quality of high susceptibility to "Yellow-edge" may undergo segregation. (See Pomology Report.)

Attempts to propagate and maintain supplies of virus-free runners have been commenced in collaboration with the Pomology and Entomology Sections. A full report of the above experiments has recently been published.* (R.V.H.)

"FRUIT-RUSSETING" and "BRANCH-BLISTER" DISEASE.

Increased attention to the methods employed for isolating, in pure culture, those fungus-types associated with typical disease symptoms, has made possible a more definite classification of the types from different sources. No other definite stage in the life-cycle of the fungus-type tentatively referred to the form-genus *Coniothecium* commonly isolated has yet arisen in pure culture, and further numerous inoculation experiments made on pot-bound trees in spring, 1931, again failed to give conclusive results concerning parasitism.

* See *Journal of Pomology and Horticultural Science*, 1933, 11, pp. 56-76.

It seems that the association of fungi with fruit-russeting and branch-blister symptoms is likely to be secondary, as a causal factor, to "tree-condition" as governed by soil-type, nutrition, cultural practice and climatic conditions. An attempt to find correlation between the distribution of disease-symptoms in the field and nutritional deficiency in the tree will be made in future work on this problem. (M.H.M.)

FUNGICIDE TRIALS.

Apple Scab and Apple Mildew.

Data have been obtained for a second year in the re-planned spraying and dusting experiment on Cox's Orange Pippin (C82). They have not been classified, but general observations clearly showed that, for the first time in the last six years at East Malling, an initial spray-application at the "green-bud" stage was really necessary for excellent Scab-control in 1932. This is considered to be entirely due to the exceptional spring weather, which was very favourable for spore-production and dispersal while making tree-growth unusually tardy. Post-blossom sulphur dusts gave good control where efficient pre-blossom protection had been afforded, while a half-strength Bordeaux mixture (4-18-100, made with hydrated lime) appeared safer to use, though less fungicidally efficient, than the full-strength spray formerly tested. Three applications of lime-sulphur, one pre- and two post-blossom, again gave very good Scab- and Mildew-control. No increase in fungicidal efficiency was shown where "Spray"-gelatine at 1 lb. per 100 gallons was used as a "spreader" for lime-sulphur with lead arsenate.

Post-blossom sulphur spraying and dusting caused fruit-drop on Cox's Orange Pippin in 1932. (See Pomology (*m*).) (M.H.M.)

Pear Scab.

A second year's tests (on the variety Fertility) on the lines of those initiated in 1931 provided very full data which have not yet been classified. The reduction in strength of both post-blossom lime-sulphur applications to 1-100 obviated spray-injury, but made the fungicidal effect of three applications in all rather less satisfactory than that of the same three applications of full-strength Bordeaux mixture (8-8-100). Colloidal sulphur was again unsatisfactory. On the whole, Bordeaux mixture appears to be much preferable to sulphur sprays in the control of this disease. (M.H.M.)

FACTORS AFFECTING SUSCEPTIBILITY TO APPLE SCAB AND MILDEW.

A large number of data on the effect of rootstock and manuring on susceptibility to Scab in Bramley's Seedling and Worcester Pearmain have yet to be classified. Further data have been obtained on the effect of rootstock on Scab- and Mildew-infection in Cox's Orange Pippin. (M.H.M.)

DISEASES OF WALNUTS.

Walnut Bacterial Blight.

Bacteria isolated from leaf-spots on established walnut trees in Sussex, Surrey and Kent, have now been proved by inoculations to be parasitic.

In November, 1931, bud scales of young walnut trees were inoculated with the blight organism, as it was expected that it might overwinter in such a position. Negative results, however, were obtained when the buds grew out in the following spring.

To control walnut blight on the nursery trees, stem lesions were cut out of all trees during the winter. Three applications of Bordeaux mixture were given in the spring and summer, a few unsprayed trees being left as controls. Owing to the dry summer of 1932 very little blight occurred on sprayed or unsprayed trees.

In relation to the occurrence of the disease in England and France, an article discussing the distribution of the disease has been published (C66).

A Disease following Grafting.

Work has been continued on the fungus (*Chalaropsis thielavioides*) associated with, and believed to be the cause of failures in grafting walnuts. Its morphology and cultural characters are being compared with those of a similar fungus isolated from carrot.

In addition to being found on walnut grafts, this fungus has now been recorded on dead rooted layers at the point where they were removed from the parent stool. It was also present on the roots of a grafted tree which had died after being planted in a permanent position.

Experiments have been carried out to test the parasitism of the fungus. Plants that were inoculated during grafting all failed to form a union, while controls remained healthy and grew out normally.

In April, 1932 tap-roots of seedling walnuts were inoculated with *Chalaropsis* from walnut. The inoculated plants and controls were potted up, and examined in the autumn of 1932. In every case a positive result was obtained from those that had been inoculated.

As *Chalaropsis thielavioides* has previously been recorded only as a parasite of lupins in Italy, lupin seedlings were inoculated with pure cultures of the fungus from walnut and carrot. In every case lesions resulted.

In the winter of 1931, after trying out various solutions, it was found that 1 per cent formalin is toxic to *Chalaropsis* spores. This solution gave a good control of the fungus in the greenhouse. (See Pomology Section.)

A Botrytis Parasitic on Walnuts.

Reddish-brown lesions were noticed on nursery trees during March, 1932. A *Botrytis* was isolated easily from any lesion. This fungus has since been proved by inoculations to be parasitic on walnut stems. (J.B.H.)

OTHER DISEASES.

Grey Mould on Apple Roots.

In January, 1932, *Botrytis cinerea* was found on the roots of one-year-old bedded stocks (East Malling, No. VII). Many roots were brown and dead and these bore the fructifications and sclerotia of the fungus. Other stocks were free from this trouble and it is considered that the No. VII stocks became infected by reason of their very fibrous roots, which, in the "bedded in" bundles retained an excessive amount of moisture, thus favouring attack by *Botrytis* (C79). (H.W.)

Lilac Bacteriosis.

A severe outbreak of bacteriosis in lilacs on a farm in Wiltshire has been studied, as it appears to be the first authentic record of lilac bacteriosis in this country. A bacterium has been isolated from infected shoots and leaves, and in preliminary tests this organism shows affinity with *Bacterium syringae* which has been found to infect lilacs on the Continent and in the United States. This organism is of interest from a pomological point of view for recent American investigations show that *B. syringae* is closely related to, if not identical with *B. citriputeale*, which is the cause of citrus "Blast" and with *B. cerasi* which infects cherry trees. A brief account of the outbreak has been published (C76). (H.W.)

ENTOMOLOGY

THE CONTROL OF THE FRUIT TREE RED SPIDER.

A preliminary spraying trial was carried out in the winter of 1931-32 to test the toxic properties of some petroleum washes and tar-petroleum washes of known composition against the eggs of the Fruit Tree Red Spider.

The sprays were applied at a strength of 10 per cent in February.

The sprays gave a measure of control varying from 40 to 80 per cent, while the percentage of mites hatching from the eggs in the absolute controls was eighty-four. The treatments giving the better control included two containing tar oils and one consisting of a "straight" petroleum.

Tests with the more favourable of these sprays are being designed for the coming season. (A.M.M.)

THE RESISTANCE OF DIFFERENT ROOTSTOCKS TO WOOLLY APHIS ATTACKS.

Some 773 apple seedlings, raised at Merton and East Malling, have been tested again during the year. Of this total some 546 Northern Spy crosses, and including No. IX and No. II selfed, raised by Mr. M. B. Crane of the John Innes Horticultural Institution, Merton, and tested at East Malling, gave interesting results. Two hundred and thirteen proved to be immune to aphid attack, while forty were included in the highly resistant group. The remainder were contained in the very susceptible class. Of the Spy crosses raised and tested at East Malling 145 proved to be resistant, while 131 were placed in the susceptible group.

An outstanding feature of this year's experiments is that the number of immune and highly resistant seedlings is much greater than usual. At present there appears to be no explanation for this phenomenon.

The nineteen seedlings found to be immune in the season of 1931 have been tested for the second year and the immunity characteristics hitherto exhibited have been maintained.

A number of selected immune seedlings (Spy $\times$ II) which were tested at East Malling, have been forwarded to Canada, New Zealand and South India, in order to ascertain whether the immunity characteristics will be maintained under the varying climatic conditions of those countries. The stocks are being tested purely from an entomological point of view, and at present they are not for general distribution. (A.M.M.)

CAUSES OF IMMUNITY.

The investigations in relation to the causes of immunity to woolly aphid, hitherto carried out in conjunction with the Biochemical Station, have been held over during the year, but fortunately a temporary worker will be available during the coming summer months, and the investigations will therefore be continued. (W.A.R., A.M.M.)

WOOLLY APHIS PARASITE.

The Woolly Aphis parasites liberated in an orchard near Maidstone in 1931 survived the winter of 1931-32 and were still present in the plantation during the summer of 1932. The remains of parasitized Woolly Aphides were easily detected on the trees,

but the parasite population did not appear to be very great. This work is being carried out in collaboration with the Plant Pathological Laboratory, Harpenden, Herts.

(A.M.M.)

THE APPLE FRUIT SAWFLY INVESTIGATIONS.

Some new and interesting observations on the life-cycle of this insect have been made during the season of 1932. It has been ascertained that a considerable proportion of the larvae make what might well be termed a "temporary nocturnal migration". This form of migration takes place during the period from the hatching of the egg until the larvae are ready to go into the soil. The larvae come out of the developing fruitlets after night-fall, and they usually go back again before daylight. It has been noted that once a Sawfly larvae migrates from one fruitlet, it may not go back into the same fruit again, but may attack a healthy fruitlet in the same truss. Thus all the fruitlets in one truss may be ruined by one larvae.

A preliminary account of these observations has been published (D81).

(A.M.M.)

SYSTEMATIC STUDY OF GALL MITES.

A systematic study of the Gall Mites which infest plants is being continued and a new species from South India has been described. A description of the mite together with details of the gall formation produced by the species is in the press.

(A.M.M.)

A NEW TARSONEMID MITE.

A species of Tarsonemid mite hitherto unknown in this country was sent to East Malling for determination. The mite occurs on bulbs. The species has been determined as being *Tarsonemus approximatus* var. *narcissi* Ewing. A detailed account of the mite has been forwarded for publication.

(A.M.M.)

THE STRAWBERRY TARSONEMID MITE.

It has now become definitely established that the Strawberry Tarsonemid Mite is commonly distributed in this country and that it attacks many commercial varieties (D76).

It has also been shown that direct mite injury to the plant may result in the plant losing its vigour, and cause general deterioration. In addition it has been noted that once a badly mite infested plant has been cleaned of mites, the plant may or may not regain its vigour. When the plant does not recover it is suggested that some other factor may be present, but that it is masked by the severity of the mite infestation.

CONTROL MEASURES.

It has been found that lime-sulphur applied at a strength of 3 per cent will kill the mites, but this treatment is by no means efficient since it does not affect the eggs. Other acaricides are being tested, and it has been found that white oil preparations are not very efficient against the mite.

In a preliminary experiment it has been found that the treatment of strawberry plants by sterilizing them in hot water at a given temperature, for a known period, has given very satisfactory indications. The plants are not damaged by the treatment, but the mites and their eggs are destroyed.

(A.M.M.)

STRAWBERRY "YELLOW-EDGE" DISEASE.

Investigations are being continued in collaboration with the Mycological Section to determine whether the mite (*T. fragariae* Zimm.) is associated with the transmission

of the virus causing the disease described as " Strawberry Yellow-edge ". Direct inoculation experiments have been made with mites fed on diseased and healthy plants, but at present no positive results have been obtained, because the plants became so badly mite infested during the Autumn, that any other symptoms which may have been present would be masked by mite attack. The plants have now been freed of mites, and they will be kept under observation next year. (A.M.M.)

THE BLACKBERRY MITES.

It has been possible to make a few observations on the Gall Mite which causes " Redberry Disease " but no control measures have been attempted this year. (A.M.M.)

THE APPLE BLOSSOM WEEVIL.

Further observations on the life-cycle of the Apple Blossom Weevil have been noted, and these are fully described in an account published recently (D82).

Further trials have been carried out with various types of corrugated bands which had been chemically treated in an attempt to render them less liable to attack by birds and mice. The results are encouraging, but the investigation must be continued, since a number of the treated bands have been subject to attack by birds, though not to the same extent as the untreated ones.

A preliminary trial has been started to determine whether Apple Blossom Weevils can be induced to shelter in chemically treated bands which will in time destroy the weevils. Tests made with bands treated with Beta-Naphthol gave negative results. (A.M.M.)

THE APPLE FRUIT TORTRIX.

Preliminary observations on the habits and life-cycle of this Tortrix (*Batodes* sp.) have been made during 1932. This pest is now very serious in some districts in Kent, 50 per cent of the crop in some plantations being affected. (A.M.M.)

RASPBERRY AND LOGANBERRY BEETLE.

Observations continued to be made on the habits of this pest with special reference to the larvae, and further field trials on raspberries and loganberries were carried out with Derris sprays and dusts of known rotenone content.

Whilst amply confirming the adequacy of the East Malling double spraying method of control (which entails spraying with Derris in the middle and towards the end of June (A14, D75, D79)), these trials showed also that the larvae can be attacked at a rather later stage than was originally thought desirable. In fact as good results were obtained with one spraying (omitting the mid-June application) as with two. Confirmation of this is forthcoming from the results of delayed applications of Nicotine to raspberries and the observed fact that larvae do not do any damage of consequence till late June or early July.

A dust of known rotenone content again gave good results on raspberries when used against the larvae but was rather less efficient than wet sprays for this purpose.

Preliminary experiments showed that the pest could be controlled in its larval stage on cultivated blackberries by means of Derris, though details as regards number and time of applications remain to be worked out.

The 1932 spraying trials, to the success of which the chemical assistance and advice given by Dr. Tattersfield of the Rothamsted Department of Insecticides materially contributed, form a basis for further work towards the standardization of Derris sprays

and dusts. The full details of these trials will shortly be published, and the previous year's results have already appeared (D75).

A leaflet dealing with the control of this pest was prepared for issue to growers and enquirers (Misc. Pub. 12), and is being revised from time to time. (W.S.)

OTHER RUBUS PESTS.

Observations were made on *Eucosma (Aspis) uddmanniana* (Bramble Shoot Moth) on loganberries and blackberries, and on *Rhynchites aenovirens* on loganberries, blackberries and raspberries. The latter is apparently an hitherto unrecorded pest of Rubus with somewhat similar habits to the Apple Twig Cutting Rhynchites, but is not at present of great importance. (W.S.)

INSECT TRANSMISSION OF RASPBERRY MOSAIC.

The infection experiment with potted plants of Lloyd George and Baumforth B has been continued, but without any positive result to date. (W.S.)

CAPSIDÆ.

In collaboration with Wye College a winter spraying trial against the Apple Capsid (*Plesiocoris rugicollis*) planned on statistical lines, was carried out on a commercial farm. The sprays used were, a light lubricating oil, a strained anthracene (tar) oil—both of known characteristics—and a mixture of these. Very good control of Capsid was obtained with sprays containing 6 per cent of the mineral oil, with or without the addition of 4 per cent of the tar oil. The results are being prepared for publication. (W.S.)

DERRIS.

Some preliminary biological tests have been made with a view to developing a technique for use in extensive biological tests to be carried out jointly with Dr. Tattersfield (Rothamsted). (W.S.)

HOPS

CULTURAL TRIALS.

The investigation of the effect of the distance between the hills and the number of bines trained up each string on the yield and on the size of the cones has been continued. Although the weather conditions in 1932 were very different from those of 1931 the relative cropping of the plots remained unaltered, the yields again being markedly increased by closer planting. The number of bines trained up each string still appears to affect the yield much less markedly than the distance apart of the hills. On inspection of the plots at picking time the cones on all plots appeared very well developed but the grading of random samples of cones showed that the significant differences in size between the treatments noted last season still remained.

Samples of the dried hops of the 1931 growth were taken from plots having the two extreme treatments (3 ft. apart, three bines per string, and 9 ft. apart, one bine per string) and analysed for preservative value by Mr. Burgess of the South-Eastern Agricultural College. The cones from the hills 9 ft. apart proved slightly the richer. An analysis of this year's hops is being made in order to see if the difference in preservative value is maintained.

The Seedling OV7 (Late Bavarian $\times$ English Male) has been propagated in sufficient quantity to allow of half an acre of this variety being planted during the winter. This area will be used for further cultural trials and to provide material for brewing tests and also sets for distribution to growers.

The two half acre plots of seedling OP21 and the commercial variety Fuggles, planted in October, 1931, are being allowed to become thoroughly established before the proposed trials of severity in cutting and pulling are commenced.

MANURIAL EXPERIMENTS.

A report on the pot culture experiments has been published giving the results of five years' observations (Br8). Descriptions of the foliage characters associated with omission of certain elements from the nutrient solution are given and the effect of the treatments on growth, weight of bine and rootstock and cone formation are also discussed.

NEW SEEDLINGS.

A further twenty of Professor Salmon's new seedlings have been planted out for a preliminary trial and a corresponding number of varieties which have proved to be unworthy of further testing have been grubbed. The crops from over 180 seedlings were dried separately and the number of bushels of green hops and the weight of dried hops recorded. Bottle samples of the dried hops for resin analysis were taken from over 100 varieties. The cold wet summer of 1931 had a depressing effect on the yield and the preservative value of the hops, but many of the seedlings were richer in preservative value than comparable commercial varieties. Among the early hops in 1931 X35 proved once again to be richer than the Bramling. In the midseason hops seven varieties were higher in preservative value than the richest commercial variety (Mathon) and one of these had not been previously tested.

Of the late varieties eleven seedlings proved richer than the richest commercial hop (Canterbury Golding). One of these, OP21 is one that can be unhesitatingly recommended for the English market, and it is being propagated in quantity for distribution in the near future. The seedling C9a which in the three previous seasons proved richer than the richest American hops, came very slightly below it in 1931.

The evidence which has been gathered during the past few years indicates that several of the "Manitoba Seedlings" of which C9a is an example, and also certain of the "New Mexican Seedlings" may have a commercial future in this country as hops suitable for "Stouts", with a preservative value equal to good American hops. This work is being carried out in collaboration with Professor Salmon who has published a report, and Mr. Burgess of S.E. Agricultural College.

INCIDENCE OF DOWNY MILDEW.

The attack of the "spike" form of the disease was extremely severe, a special feature being the very large number of lateral "spikes" in the axils of the leaves during the second half of June and the early part of July.

Two applications of Bordeaux mixture were given (27th July and 10th August) which gave satisfactory control of the disease on the cones with few exceptions. From observations made this season it appears that the dates for applying the Bordeaux mixture to secure full control vary considerably with the variety and that with an experimental garden of several hundred varieties of all seasons and varying degrees of susceptibility it is difficult to obtain a perfect control of the disease on every variety.

(F.H.B. and J.A.)

Section III

PRELIMINARY RESEARCH REPORTS

POMOLOGY

CONFERENCE PEAR HARVESTING EXPERIMENT

By R. C. PALMER *

Project Started.—21st September, 1931.*Object.*—To secure information regarding the influence of maturity at harvest time on quality and storage behaviour of Conference pears.*Procedure.*—The entire crop was harvested from six trees of Conference worked on Quince A. These trees were Nos. 1, 2, 3, 4 and 5 of Row 2, and No. 5 of Row 3. Each of these trees carried a medium to light crop, much of which was distributed in unthinned clusters. In the case of trees 3 and 4 of Row 2, the entire crop was picked on 21st September and graded into three sizes, under $1\frac{3}{4}$ ins., $1\frac{3}{4}$ to 2 ins. and over 2 ins. in diameter. In the case of trees 1, 2 and 5 of Row 2, and tree 5 of Row 3, four pickings were made, on 21st September, 26th September, 1st October and 5th October respectively. At the 21st September picking, all fruits less than 2 ins. in diameter and fifteen fruits 2 ins. or more in diameter were harvested from each tree. On trees 1 and 2, Row 2, the remaining fruits were encased in cotton bags to prevent injury from birds. On trees No. 5 of Row 2, and No. 5 of Row 3, the fruit remaining unharvested after 21st September was left unprotected. At the 26th September, 1st and 5th October pickings, fifteen fruits were harvested from each tree. The ease with which the fruit could be picked, the number of bird pecked specimens and the number of drops were recorded for each tree on each picking date.After picking, the pears were taken to the Pomology Laboratory, where they were graded for size and tested for hardness by means of a mechanical pressure gauge which records the pounds pressure required to force a rounded metal point into the flesh of the fruit. Two readings were taken on each pear, the point being applied to the peeled flesh on opposite sides of the fruit in the region of the bulge. With the first picking five pears of each of the three sizes (under $1\frac{3}{4}$ ins., $1\frac{3}{4}$ to 2 ins. and over 2 ins.) from each tree were tested. With the three subsequent pickings, five pears from each tree, graded from $2\frac{1}{4}$ to $2\frac{3}{4}$ ins. were tested. The number of seeds in each of these pears was recorded.

The remaining fruits were kept in the Pomology Laboratory where the temperature ranged from 60° to 70° F. and the relative humidity registered between 60 and

* Mr. R. C. Palmer, now Superintendent of the Dominion Experimental Station, Summerland, B.C., came to East Malling in 1931-32 under an arrangement for exchange of workers. In view of his valuable contributions in Canada on questions of optimum maturity of fruits at harvesting (see R. C. Palmer, "Apple Storage Investigations." Summerland Experimental Station: Report of the Superintendent for the year 1930, 1931 and "Recent Progress in the Study of Jonathan Breakdown in Canada", *Scientific Agriculture*, XI, 5, January, 1931) he was especially asked to initiate us, in a very short space of time, into his technique for developing these studies at some future date. He kindly left us his preliminary data to deal with as we thought fit. The results are presented here since we consider the whole question deserving of following up when opportunity offers.—ED.

85 per cent. Record was kept of the date each sample reached prime eating condition and the date when 50 per cent of the fruits in each lot had become over ripe as evidenced by softening of the flesh in the "neck" of the pear.

An attempt was made to ascertain comparative development of quality by tasting fruit of each lot when in prime eating condition, flavour being recorded as good, fair or poor. Record was also kept of the percentage of each lot which developed serious wilting.

Experimental Data.—Picking notes indicate a wide range in the ease with which individual fruits from the same tree could be picked on 21st and 26th September, some coming off quite easily, while others necessitated the use of both hands to remove them without damaging the spurs. By 1st October practically all the fruits could be removed with ease. There were some drops at the time the first picking was made, but loss from this cause and from bird injury was not serious until after 26th September.

Pressure tests on pears of the same size picked on 21st and 26th September and 1st and 5th October respectively, suggests that the pears left on the trees softened appreciably between 21st September and 1st October. Data bearing on this point are presented below.

The average hardness at each picking date for each of four trees is shown in Table I, each figure being the average of ten pressure tests. The mean hardness for the four trees is given at the foot of each column. The standard error appropriate to these means is 0.16 and from this the difference which can be adjudged significant between any pair of these means is found to be 0.45.

Thus there is a definite softening between 21st September and 1st October but not after this date.

TABLE I.
HARDNESS OF CONFERENCE PEARS AT HARVEST TIME.

Row Number.	Tree Number.	Average hardness at each picking date.			
		21st September.	26th September.	1st October.	5th October.
2	1	17.3	15.4	15.6	15.9
2	2	17.0	15.8	15.3	15.6
2	5	16.8	16.3	15.6	15.2
3	5	17.5	16.4	15.2	15.3
Mean		17.02	16.01	15.42	15.52
Standard Error*		0.16			

However, there was also a wide range in hardness in fruits of different sizes picked from the same tree on the same date.

The average hardness of each size for each tree and the mean of the six trees is shown in Table II. Again ten pressure tests were made on each tree. The standard error in this case is 0.17 and the significant difference 0.48. The differences of 1.17 and 1.43 between the means of the different sizes are therefore quite definite, showing the hardness to decrease with increasing size of fruit.

* Where tests of the significance seemed necessary, these data have been analysed statistically and the appropriate standard errors added to the author's tables with his full permission. These tests, in all cases, fully confirm his conclusions.—ED.

Furthermore, the variation in hardness between individual pears of the same size picked from the same tree on the same date was quite large. In fact there was often a difference of more than a pound in the hardness of opposite sides of the same pear.

Cutting tests revealed the fact that all the fruits below 2 ins. in diameter were seedless, and less than 10 per cent of the fruits over 2 ins. in diameter contained any

TABLE II.

HARDNESS OF CONFERENCE PEARS PICKED ON 21ST SEPTEMBER.

Row Number.	Tree Number.	Average hardness of each size.		
		Under $1\frac{1}{4}$ ins.	$1\frac{1}{2}$ to 2 ins.	Over 2 ins.
2	1	18.4	18.5	17.3
2	2	18.6	18.0	17.0
2	3	20.4	18.8	17.8
2	4	20.6	19.6	18.1
2	5	21.3	18.1	16.8
3	5	20.2	19.6	17.0
	Mean	19.94	18.77	17.34
Standard Error		0.17		

seeds. Pressure tests suggested that the few fruits which contained one or more seeds each were slightly softer than seedless fruits of the same size picked from the same tree on the same date.

While fruits from all four pickings ripened very rapidly under the high temperature conditions at which they were kept, the length of the period between picking and maturity was materially shortened by delayed harvesting. This statement is substantiated by the data incorporated in Table III.

TABLE III.

RIPENING PERIOD OF CONFERENCE PEARS.

Date picked.	Days between Picking and Eating Ripe.			
	Row 2, Tree 1.	Row 2, Tree 2.	Row 2, Tree 5.	Row 3, Tree 5.
21st September ..	15	14	14	15
26th September ..	12	12	12	12
1st October ..	9	9	9	9
5th October ..	7	7	8	7

On the other hand, the length of the period during which the fruit remained in good eating condition was so short and so variable (2 to 5 days), that a comparison of the results for the different picking dates in this connection is of little value.

Quality determinations showed that the medium and large sized fruits from all pickings developed satisfactory flavour and texture, but the pears less than 2 ins. in diameter, which were all picked on 21st September, had a closer grained flesh, less melting texture, lower sugar content, less attractive flavour and greater astringency than is desirable. The fact that these small fruits occurred in clusters on the previous year's terminals suggests that they may have been the result of a second bloom. A quality test conducted with the aid of the Research Station staff showed that eight out of eleven people considered pears containing seeds were superior in quality to seedless specimens of similar size picked from the same tree on the same day. Wilting was not excessive except in the small sized fruits picked on 21st September, but even the large sizes picked on this date shrivelled more than is desirable.

Before attempting to draw conclusions from this project, it will be necessary to repeat the work over a period of years with trees of various ages growing under various conditions. However, the results secured from this preliminary experiment suggest some interesting lines along which further investigations should be conducted.

APPLE HARVESTING INVESTIGATION

By R. C. PALMER

Project Started.—17th September, 1931.

Object.—To secure information regarding the influence of rootstock on the maturity of Lane's Prince Albert apples.

Procedure.—The entire crop from nine trees of Lane's Prince Albert, three on stock IX, three on stock VII and three on stock XVI, was picked on 17th September. Notes were made at picking time with regard to the ease with which the apples could be removed, the position in which they were borne, and the range of sizes. Immediately after picking the fruit was removed to the packing house and graded for size and skin colour. Pressure tests were made on five apples of each size within each colour grade from each tree. Two tests were made on each apple, a rounded metal point $\frac{7}{16}$ of an inch in diameter being forced into the peeled flesh to a depth of $\frac{5}{16}$ of an inch, and the pressure required to perform this operation recorded in pounds on a scale. Similar pressure tests were made on the opposite sides of apples which had one red or russeted cheek to ascertain the influence of red colour and russetting on hardness.

Experimental Data.—The notes made at harvest time indicate that there was quite a wide range in ease of removal even with fruits on the same tree. In general, however, the apples were more firmly attached to the trees worked on stock XVI than was the case with the trees on stocks IX and VII. No thinning had been practised and on all three stocks there were many "doubles". In most cases the fruits were borne on short spurs. On stock XVI most of the fruits were large, but on the other two stocks there was a wide range in size of fruit. There was more russetting and more red colour development on the fruit from trees on stock IX. This fruit had greater exposure to light than that on stock VII. Similarly there was less shading of the fruit on stock VII than on stock XVI. All the trees on stock IX and one of those on stock XVI carried a medium crop for their size. The other two trees on stock XVI and the three on stock VII carried a light crop for their size.

TABLE I.

PERCENTAGE OF CROP WITH "GREEN" SKIN COLOUR.

Stock.	Tree 1.	Tree 2.	Tree 3.
No. IX	41	57	38
No. VII	43	39	53
No. XVI	70	39	42

By means of a colour chart the fruit from each tree was graded into two colour classes, a "yellow" grade in which the skin showed as much yellowing as colour No. 1 on the chart, and a "green" grade including all fruits of a greener shade than colour No. 1. The percentage of the crop in the "green" colour grade is shown for each tree in Table I.

From the data presented in Table I it is evident that there was no significant difference in skin colour of the fruit from the trees on stocks IX, VII and XVI. The comparatively high percentage of "green" fruit in the crop from tree 2 on stock IX and tree 1 on stock XVI is possibly due to the amount of crop carried, as the yield records show that these two trees bore a materially heavier crop than the other trees on the same respective stocks.

Pressure tests did not reveal any significant difference in hardness between fruit of the same size grade from the three stocks. Data supporting this statement are shown in Table II. Each figure is the average of ten pressure tests.

TABLE II.
INFLUENCE OF STOCK ON HARDNESS OF FRUIT.

Stock.	Average hardness of 3 to 3½ inch apples.		
	Tree 1.	Tree 2.	Tree 3.
No. IX	16.2	16.3	16.6
No. VII	16.0	16.1	16.9
No. XVI	16.2	16.9	17.2

Similarly there was no material difference in hardness between "yellow" and "green" apples of the same size, as is evidenced by the data set forth in Table III.

TABLE III.
INFLUENCE OF "YELLOW" COLOUR ON HARDNESS.

Colour Grade.	Average hardness of 3 to 3½ inch apples.		
	Tree 1.	Tree 2.	Tree 3.
"Yellow"	16.2	16.1	16.2
"Green"	15.7	16.2	16.2

There was, however, an appreciable difference in the hardness of the three size grades even in apples picked from the same tree, as can be ascertained from a glance at the data presented in Table IV.

TABLE IV.
INFLUENCE OF SIZE OF FRUIT ON HARDNESS.

Diameter of fruit in inches.	Average hardness of apples of three sizes.				S.E.*
	Tree 1.	Tree 2.	Tree 3.	Mean.	
2½ to 2¾ ..	18.7	19.9	20.3	19.64	0.20
2¾ to 3 ..	18.1	18.7	19.7	18.85	
2¾ to 3 ..	17.4	17.2	17.9	17.53	

* Where tests of the significance seemed necessary, these data have been analysed statistically and the appropriate standard errors added to the author's tables with his full permission. These tests, in all cases, fully confirm his conclusions.—ED.

The averages for the thirty pressure tests (ten on each of three trees) on the fruit on each of three size grades were 19.64, 18.85, and 17.53. The standard error was 0.20 which shows a difference of 0.57 between any pair of these averages to be significant. Large apples were thus significantly softer than small.

Furthermore there was a material difference in the hardness of opposite sides of individual apples having a "red" cheek, the "red" side being almost invariably harder than the "green". The truth of this statement is borne out by the data presented in Table V. Each figure is the average of tests made on ten apples.

The difference in mean hardness was 1.1 and this is considerably greater than the significant difference which in this case would have to be 0.53.

TABLE V.
INFLUENCE OF RED COLOUR ON HARDNESS.

Side of Fruit.	Average hardness of $2\frac{3}{4}$ to 3 inch apples.				S.E.
	Tree 1.	Tree 2.	Tree 3.	Mean.	
"Red" ..	18.7	18.0	17.7	18.14	0.19
"Green" ..	16.9	17.2	17.0	17.04	

Similarly russetting of the fruit resulted in a materially greater resistance of the flesh to pressure as is indicated by the data incorporated in Table VI. Each figure is the average of tests made on ten apples.

In this case the russet side of the fruit has a mean hardness of 18.04 while the green side averages 16.87. The difference to be significant must be 0.53, the same as in Table V, showing the russet side to be definitely harder than the green.

TABLE VI.
INFLUENCE OF RUSSETING ON HARDNESS.

Side of Fruit.	Average hardness of $2\frac{3}{4}$ to 3 inch apples.				S.E.
	Tree 1.	Tree 2.	Tree 4.	Mean.	
"Russet" ..	18.2	18.0	17.8	18.04	0.19
"Green" ..	17.3	16.2	17.1	16.87	

Conclusions.—While it would be very unwise to attempt to draw conclusions from this preliminary experiment the results seem to indicate that amount of crop, size of fruit, red colour development and amount of russetting must all be taken into account when applying maturity tests to apples from trees grown on different rootstocks.

APPLE VARIETY COLLECTION

By H. C. CHAPELOW

THE following collection of varieties was got together in the early years of the Research Station with several objects in view.

The plot was laid down before the cold storage of fruit was in use by growers and good varieties that would keep well in ordinary store conditions were of special value, thus sorts like Two Year Seedling, French Crab, Wintersterne, Clark's Seedling and Ponsford were included.

High quality dessert sorts such as D'Arcy Spice, Cornish Gilliflower, Orlean's Reinette, Margil, St. Everard, Lord Burleigh, Ribston Pippin and some of the newer ones like Langley Pippin, Feltham Beauty and Monarch were also planted.

It was hoped to answer the question whether any of the better known American varieties like McIntosh, Baldwin, and Grime's Golden, could be grown to perfection in this climate.

Some Continental sorts such as Belle de Boskoop which is widely grown in Holland and Germany were added to the list.

Further, a collection with such a range of varieties would be of value for Pollination and Plant Breeding at some future date.

Altogether a nucleus of about eighty varieties was worked in 1920.

Three years later trees of another forty varieties were raised and planted on an adjoining plot, but it is not proposed to deal with this younger collection at this stage.

When the trees were worked Doucin Améliore (Improved Doucin No. V) was commonly regarded as a very satisfactory rootstock and it was accordingly used in the present trial. Our experience on other plots, however, leads us now to believe that the use of No. V rootstock has not given such good results as would have been the case had we used the true Doucin No. II. (Exception, six varieties are on Jaune de Metz No. IX.)

The site chosen for this trial was at the extreme N.E. of the Research Station, where the soil is poor, and the rock, Kent Ragstone, is very near to the surface.

The trees were planted out as maidens in December, 1921. Square plant 12 ft. by 12 ft.

With the exception of twenty varieties, mostly overseas varieties, four or six trees of each were planted. Of the twenty varieties it was only possible to plant two of each.

All cultural, manurial and spraying operations have been carried out as on the Rootstock Plots.

PRELIMINARY TREATMENT at one, two and three years of age.

After planting, the trees were cut to give a 2 foot leg, and at the end of both 1922 and 1923 they received the usual hard pruning, suitable for two and three year old trees, i.e. cut to four to six buds.

SUBSEQUENT TREATMENT.

This has been somewhat on the lines adopted by N. H. Grubb in his pruning experiments.

- (1) Regulated trees.
- (2) Leader Tipped trees.

When the trees reached four years of age one half of each unit was left with the leaders untipped, in order (a) to see how they responded to the different treatment, (b) to give an indication of their natural habit. The remainder of each unit received the usual leader tipping.

UNTIPPED TREES.

In the non-leader-tipped trees the branches were spaced, unwanted ones cut clean out. Only where mildew or canker attacked the tips were they cut.

LEADER-TIPPED TREES.

In the case of the leader-tipped trees, in each year after a survey of the plot an average length of tipping was decided upon. It was thus possible to vary the amount of tipping, when necessary, from one year to another according to the amount of growth on all the tipped trees on the plot.

SPURRING.

In both the above treatments, laterals on the outside of the trees, up to 12 inches long were left the first year and gradually worked back as definite fruit buds were formed.

Very strong laterals were entirely cut away, others spurred to five good buds (approximately 5 inches).

Table I shows all the varieties in the order of their cropping, together with total cropping to end of 1932.

TABLE I.

Total Crop in bushels per tree acre to end of 1932—when trees were eleven years of age.

ENGLISH VARIETIES.

		Untipped.	Tipped.
1	Sanspareil	2,710	2,821
3	Upton Pyne	1,952	1,629
4	Monarch	1,496	1,973
5	Red Victoria	1,885	1,387
10	Ponsford	1,671	731
11	Bridget	928	1,325
12	Clark's Seedling	1,349	891
15	Duchess of Bedford	1,164	737
16	Wanstall Seedling	1,083	752
18	Ribston Pippin	815	920
20	Cooper's Seedling	872	712
24	Edward VII on IX	642	782
26	Orange Goff	487	887
27	King's Acre Pippin	637	731
28	John Standish	736	613
30	Rev. Wilks	515	721
32	Bedford Pippin	545	652
33	Egremont Russet	627	558
35	Claygate Pearmain	716	459
37	Hornead Pearmain	624	519
38	Margil	527	593
39	Roundway M.B.	526	592
40	Owen Thomas	696	305
42	Bascombe's Mystery	760	225

		Untipped.	Tipped.
43	Irish Peach	515	458
49	Two Year Seedling	388	468
50	Rosemary Russet	464	384
52	Premier	436	361
53	Langley Pippin on IX	353	432
54	St. Everard	413	372
55	Heusgen's G.R.	529	222
56	Prothero	431	315
57	May Queen	365	380
58	Gipsy King	376	302
59	Feltham Beauty on IX	375	299
60	Gooseberry Pippin	275	367
62	Freminder	288	262
63	(Pale) Lady Sudeley on IX	262	262
64	Carter's Pearmain	280	240
66	(Red) Lady Sudeley on IX	218	253
67	Lord Burleigh	352	63
68	Pettit Pippin	223	168
70	Robert's No. 1	222	42
72	D'Arcy Spice	102	95
73	Moss Orchard	109	86
74	Cornish Gilliflower	135	32
75	Court Pendu Plat	113	37
76	King Coffee	68	3
77	Underleaf	22	—
79	Houblon	3	6

CANADIAN, AUSTRALIAN AND AMERICAN VARIETIES.

		Untipped.	Tipped.
7	Winter Banana	1,259	1,469
8	Yellow Belleflower	1,496	1,027
13	Grime's Golden	1,339	980
17	McIntosh	1,006	812
19	York Imperial	979	719
21	Stayman Winesap	885	626
22	Hubbardstone Non.	669	787
23	Fall Pippin	945	482
29	Orinoco	806	492
31	British Columbia	631	575
36	Ontario	796	385
41	Wagener	385	607
44	Orenco	465	466
45	Rome Beauty	522	379
46	Coo's River Beauty	474	444
47	Delicious	477	399
51	Baldwin	574	235
61	Akin	391	199
65	Cleopatra	221	288
69	Mother	123	161
78	Northern Spy	7	7
	Northern Spy on IX	No untipped trees	80

CONTINENTAL VARIETIES.

		Untipped.	Tipped.
2	Wintersterne	2,172	1,912
6	Calville Blanc	1,813	1,203
9	Reinette Zuccamaglio on IX	1,171	1,246
14	Belle de Boskoop	1,014	929
25	Orleans Reinette	625	754
34	French Crab	743	338
48	Transparent de Croncels	468	398
71	Sterapfel	240	12

Although as shown in this table many varieties have given considerably increased yields as Untipped, it is not advocated as the best method of treatment (except as Filler trees). Already there are indications that all except a few very vigorous varieties will quickly reach their maximum cropping and then fall off in weight and size of fruit unless leader tipped.

The crop figures show that about one-third of the number have responded to the Regulating treatment, by an increased crop of 20 per cent or more over the tipped trees.

To take only one or two extreme cases, No. 71 Sterapfel. The trees under both treatments are very upright growers and of equal vigour. In the Untipped only 60 per cent of the growth is furnished and this with either axillary fruit buds or 2 inch to 3 inch dards, no spurring being necessary. Whereas in the Leader-tipped trees 100 per cent of the growth is furnished, but mainly with laterals which have been spurred, but have not yet responded.

Again No. 74 Cornish Gilliflower is a very spreading variety of known tip-fruiting habit, the difference in cropping between tipped and regulated trees is due to the removal of fruit buds in leader cutting and that the tipped trees when spurred make very long extension growths, carrying fruit buds only at the tips, and unduly crowding the tree. When pruning it is necessary to cut out a number of these growths.

The only possible pruning for varieties like this one and some others such as Irish Peach, Red Victoria, Lord Burleigh, etc. is to space the branches, all unwanted laterals cut clean out and leave the others full length the first year.

A few varieties such as No. 11 Bridget and No. 26 Orange Goff gave some 20 per cent greater crop on the tipped trees. In the former the untipped trees are rather spreading and unbalanced, having three or four moderately strong branches, the others rather weak, whilst the leader-tipped trees are strong, open and well balanced with eighteen or nineteen branches.

In Orange Goff the trees did not come into cropping until the last two years. Those leader tipped are of moderate vigour only, whilst the untipped ones are vigorous with doubtless rather more delayed cropping.

In view of the small units of trees too much emphasis should not be placed on the deductions from the cropping figures and it should be pointed out that because a variety is low on the list it is not necessarily a poor cropper, because in certain cases trees have not yet come into cropping.

At the present stage it is not proposed to consider each of these varieties in detail, but only those of special interest.

SOME AMERICAN VARIETIES.

17 McIntosh.

Tree.—Moderately vigorous, branches rather slender, inclined to spread, makes many short dards, spurs readily.

Fruit.—D. medium size, rather soft, juicy and of good flavour, colour rich red with some yellow. At East Malling it is ready for use in early October yet keeps well in ordinary store till the end of February.

8 Yellow Belleflower (received as).

This is undoubtedly one of the variations of McIntosh, only differing from that variety in (a) growth, being vigorous; (b) colour of fruit, slightly more yellow.

21 Stayman Winesap (received as).

Another McIntosh variation, only differing from 17 McIntosh in (a) growth which is rather weak; (b) the trees are severely cankered.

Amongst other well-known varieties the following may be noted.

51 Baldwin.

A vigorous grower, very slow coming into cropping. The leaving of dards up to 12 inches long has not made for earlier cropping.

65 Cleopatra.

A very weak grower, upright and spindly, very susceptible to scab and mildew.

19 York Imperial.

Of moderate vigour, with short dards and laterals more numerous than a vigorous Allington Pippin.

41 Wagener.

A rather spindly, fairly upright slow growing tree. Keeps well till end of April.

7 Winter Banana.

A vigorous grower, makes very long, upright leader growth in the early years, later inclined to spread, eventually making a flat-topped but not a large tree. A heavy cropper of only moderate flavour. Keeping till end of March.

Others like 61 Akin ; 13 Grime's Golden ; 23 Fall Pippin ; 45 Rome Beauty ; have not responded to five bud spurring.

As an instance of stock effect it is of interest to record that Northern Spy on Doucin Améliore eleven years of age has only produced a few fruits, all of these too, in the eleventh year. Whilst on the adjoining plot, tipped trees of the same variety, but on Jaune de Metz stock, which are three years younger, commenced cropping in their sixth year and to the end of their eighth year have produced a total of eighty bushels per acre.

ENGLISH VARIETIES.

The following may be especially noted :

5 Red Victoria.

Tree.—Vigorous, spreading, tip-fruiter, does not respond to spurring.

Fruit.—A heavy cropper, early, crimson all over, very light in weight, very soft, bruises easily, susceptible to brown rot. Could not be recommended for market work.

20 Cooper's Seedling.

Tree.—A good healthy grower, moderate vigour, upright.

Fruit.—Large clean fruits of medium weight, green. A valuable early market variety, superior to Early Victoria on account of size.

30 Rev. W. Wilks.

Tree.—Rather less than moderate vigour, inclined to spread, should be leader tipped.

Fruit.—Very free cropper, early, fruit very large, very soft, excellent cooker, too soft for market.

3 Upton Pyne.

Tree.—Moderate vigour, very upright.

Fruit.—Very heavy cropper, requires thinning, good cooking quality. Originally sent out as a late dessert, but at East Malling it lacks flavour.

4 Monarch.

Tree.—Moderately strong, spreading, easily spurred.

Fruit.—Heavy cropper, requires thinning, medium to large, firm, rather susceptible to scab.

24 Edward VII.

Tree.—On IX rather weak, healthy, open.

Fruit.—Large, light green, very heavy for size, keeps well, has cropped well on IX, very late flowering. The usual cause of non setting may be due to its very late flowering after most varieties are over.

10 Ponsford and 12 Clark's Seedling.

These were included in the trial to see whether we could find something as good as or better than Bramley, but at East Malling the cropping has not been so good.

With regard to the six varieties on Metz rootstock apart from Edward VII which has already been considered, the only other variety of special mention is Langley Pippin. This has proved to be one of the newer, very early dessert apples that can be recommended.

Of other dessert varieties the following three are outstanding :

18 Ribston Pippin.

Tree.—A healthy, moderately vigorous grower, inclined to spread.

Fruit.—Has cropped well, producing fruits of good size and high quality.

25 Orleans Reinette.

Tree.—Upright, sturdy, rather slow growing, few laterals.

Fruit.—Good cropper, very late dessert of high quality.

28 John Standish.

Tree.—Vigorous, very upright, few laterals.

Fruit.—Good cropper, highly coloured and of fair quality. An attractive fruit for medium class trade.

Of the Continental varieties the only outstanding one in the group is Belle de Boskoop.

Tree.—Very vigorous, open, spurs readily.

Fruit.—Large, yellow with russet, rather poor appearance, crops freely, keeps till April. A first rate cooker and of pleasant flavour for dessert.

SUMMARY.

This preliminary report deals with the performance of a collection of eighty apple varieties to the end of their eleventh year from planting. The varieties were got together with varied objects in view and although cropping figures are given under two different treatments, it is not a variety trial. Comment has only been made upon outstanding examples.

A PRELIMINARY IRRIGATION TRIAL

By J. AMOS, R. G. HATTON AND A. C. PAINTER

EVEN modern text books, which unfortunately must to some extent generalize, usually state that a minimum annual rainfall of round about 30 ins. is necessary for the satisfactory growing of deciduous fruit without artificial irrigation. Yet in this particular spot in the South East corner of England, where apple trees make good development and the average crops do not compare unfavourably with all but the most favoured areas of the world, the average rainfall approaches only 25 ins. Nor are these 25 ins. any too satisfactorily distributed from the point of view of ensuring a long growth period, or an optimum development of crop. May, June and July are usually notably dry months, when the greatest strain of blossoming, growth and fruit bearing is presumably felt by the tree. Moreover, this particular soil series of the lower Greensand formation is exceedingly well drained over the porous rock, and but for a very thin vein of clayey material, sometimes appearing deep down over the Kent ragstone, there is very little moisture retaining material apparent in this light loam. Unless kept under a good tilth or heavily manured, apple trees show the effects of grass orcharding rapidly, and, in periods of summer drought, the leaves of apple trees often become yellow and wilt even where a good soil mulch is maintained.

The phenomenal tree development and crops harvested in the best plantations of British Columbia, Washington and Oregon, where a very much lighter rainfall than our own is supplemented by regular and generous irrigations, naturally suggested that this aspect of apple growing might be worth exploring in the South East of England, despite our very limited hours of sunshine.

The project appeared even more worth while after seeing the value attached to a partial irrigation in an apple growing district such as the Doncaster area of Victoria, Australia, where the winter surface rains are collected in ponds or reservoirs for a single flooding of the plantation as need appears to dictate.

An opportunity for a preliminary experiment of this kind occurred during the early summer of 1932 at East Malling. Unfortunately the choice of available material and the position of the water mains were limiting factors. A series of notoriously variable Early Victoria apple trees on seedling Crab stocks (records on the history of which were fairly complete) appeared most suitable, since the virtue of the variety depended upon the production of good sized early culinary fruit, and it was thought that, if a partial irrigation of the type contemplated were to show any results, it might most likely be apparent in the larger size of the fruits on the irrigated trees. All the trees in the experiment were carrying heavy crops. On 25th June, during a dry spell, a single artificial irrigation was applied.

Although some 3 ins. of rain had fallen during May, in June only .7 of an inch—or half the normal average for the month—was recorded. The soil, which has already been described, was noticeably dry and hot at the time of the experiment, when presumably any help given to the trees might be expected to affect the time of marketing of this July apple.

The water was supplied by means of three furrows drawn out with a plough, about 4 ins. deep, on both sides of the row (B) of trees to be irrigated. The row consisted of eight Early Victorias planted alternately with eight James Grieves at 14 feet. Only seven of the eight Early Victoria trees were recorded for this experiment, since the eighth was being utilized for an intensive blossom thinning trial.

On either side of this row were similar "buffer" rows separating row B from row D which was left unirrigated. Therefore, in calculating the water used and supplied, it must be realized that the water was to some extent shared by these buffer rows of trees adjoining the furrows on one side. It was therefore planned that the quantity of water sent into the furrows should be sufficient for two full rows of trees (i.e. 32) though actually only one full row and a single side of two other rows received the application. Steel spraying mains, $1\frac{1}{2}$ ins. in diameter, were used to convey the water from the Company's mains, (which deliver at a pressure of approximately 150 lbs. per sq. in.,) to the plot. The "flow" was directed and regulated into the furrows by means of stopcocks (see Fig. 1). The actual quantity of water supplied was 10,800 gallons. It was regulated to run slowly down the furrows, i.e. $5\frac{1}{2}$ -6 gallons per minute over a period of 30 hours. This quantity was reckoned to be equivalent to 3 ins. of rain over the same period. On an acreage basis the application would have worked out at some 67,866 gallons. The cost of the application—using Company's water at 2s. 3d. per 1,000 gallons—works out at approximately £7 12s. 7d. per acre or $8\frac{1}{2}$ d. per tree (222 trees per acre). It is not

TABLE I.
EARLY VICTORIAS ON CRAB—"GRADE" ANALYSIS OF CROPS.

Row B (7 trees) Irrigated Row.					
Grade.	1930.*		1932.		
	lbs.	%	lbs.	%	
Over $2\frac{3}{4}$ ins.	—	—	14	1.0	
" $2\frac{1}{4}$ to $2\frac{3}{4}$ ins.	5	.5	99	7.5	
" $2\frac{1}{4}$ to $2\frac{1}{2}$ ins.	47	5.0	753	57.0	
" 2 to $2\frac{1}{4}$ ins.	181	10.0	410	31.0	
" $1\frac{3}{4}$ to 2 ins.	524	60.0	52	4.0	
Under $1\frac{3}{4}$ ins.	121	14.0	2	—	
V. smalls	9	1.0	—	—	
Total Fruit Picked	887		1330		

Row D (7 trees) Non-Irrigated Row.					
Grade.	1930.*		1932.		
	lbs.	%	lbs.	%	
Over $2\frac{3}{4}$ ins.	—	—	15	1.25	
" $2\frac{1}{4}$ to $2\frac{3}{4}$ ins.	11	1.3	105	9.0	
" $2\frac{1}{4}$ to $2\frac{1}{2}$ ins.	82	10.0	700	58.0	
" 2 to $2\frac{1}{4}$ ins.	194	23.0	330	28.0	
" $1\frac{3}{4}$ to 2 ins.	471	55.0	39	3.0	
Under $1\frac{3}{4}$ ins.	96	11.0	5	0.5	
V. smalls	1	—	—	—	
Total Fruits Picked	855		1194		

* 1930 and 1932 are the only comparable years—1929 and 1931 the trees were in their "off" year.

suggested that, even if it were permitted on a large scale, this source of supply would necessarily prove the most economic.

Soil moistures were determined on samples taken actually in the tree row (B) before and after irrigation (at a distance of approximately 4 feet from the furrows). These showed an increase of 1 per cent of moisture in the top 10 ins. of soil. Moistures were also determined on samples taken from between the tree rows which had been irrigated and those which had not. These showed an increase in the irrigated row of 4 per cent of moisture in the top 9 ins. of soil, of 1 per cent in the second 9 ins. and no increase in the third 9 ins. This suggests a slow movement of the water downwards and a still slower movement laterally. The irrigated and non-irrigated plots were both cultivated 20 hours after the irrigation water had been turned off. The soil samples mentioned above were taken at this time. These samples were first air dried and finally dried at 100° C. for 24 hours.

The fruit, which had been thinned to singles earlier in the season, as the trees were all carrying heavy crops, was picked over twice—on 4th and 10th August—and graded tree by tree into six size grades with the results shown in Table I (see page 65).

From this it will be seen that the proportion of fruit in the different size grades was approximately the same.

The total quantity picked was rather larger in the case of the irrigated row, but an examination of the crop records of the four previous years shows that this has always been the case.

Figures are also given for the 1930 crop which is most nearly comparable, the trees being also then in their "on" year.

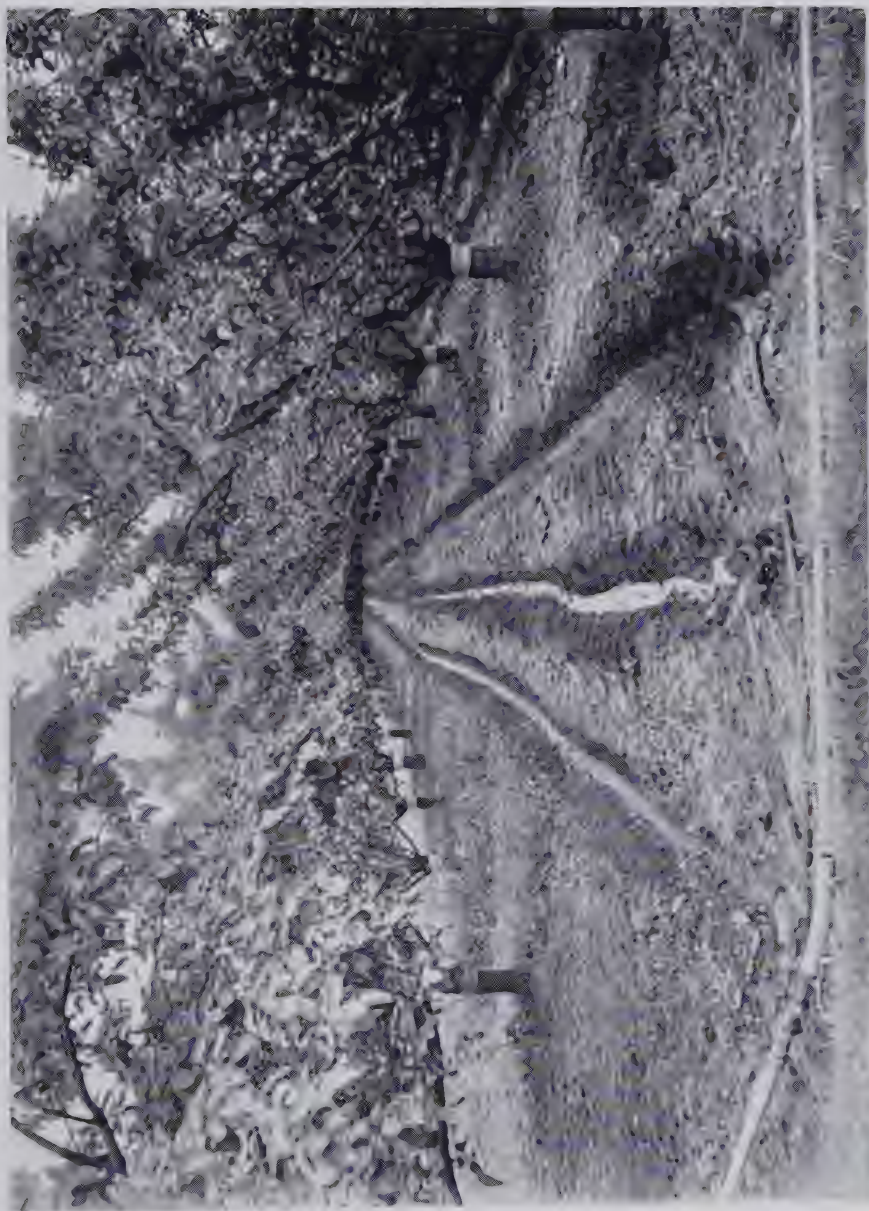
Table II gives the total number of fruits picked from these two rows for the last four years, together with their total weight and the average weight per fruit.

TABLE II.
EARLY VICTORIAS ON CRAB—ANALYSIS OF CROP RECORDS.

		Row B (7 trees) Irrigated Row 1932.			
		1929.	1930.	1931.	1932.
Total Fruits (including drops)		9455	7740	3119	8994
Weight		1034 lbs.	913 lbs.	476 lbs.	1329 lbs.
Average Weight per fruit		0.109	0.118	0.153	0.148

		Row D (7 trees) Non-Irrigated Row.			
Total Fruits (including drops)		6737	7085	1674	8166
Weight		780 lbs.	874 lbs.	234 lbs.	1202 lbs.
Average Weight per fruit		0.116	0.123	0.14	0.147

While the average weight per fruit in 1930 was rather higher in the case of row D (subsequently the non-irrigated row) in 1932, when the trees were irrigated, it was about the same. The difference, however, appears to be too small to make it significant. Again, although figures suggest that the irrigation slightly reduced the number of "drops" and may have actually slightly delayed the maturity of the fruits for picking, the material used was far too irregular, the number of trees in consequence far too small, the personal element in thinning and picking too much of a disturbing factor to permit the actual



Showing method of irrigating 18 year old apples.

differences being regarded as really significant. One thing, however, is clear, namely, that the single application of 3 ins. of water at that period had no striking effect upon the weight, size or earliness of the crop picked. It is therefore probable that such a procedure is not a vital factor, and that even where our apple trees might be expected to benefit noticeably, "dry farming" is at least adequate to meet their conditions. Having explored the possibilities and established a rough technique which could be readily criticized and improved upon, it is hoped that, as opportunity offers and the vagaries of our climate allow, this preliminary deduction may be explored more accurately.

SUMMARY.

The objects of and technique used for carrying out a preliminary "partial irrigation" test on apples at East Malling are described. Negative results on the crop are reported.

CULTIVATED BLACKBERRIES, DEWBERRIES AND HYBRID BERRIES—A PROGRESS REPORT

By A. B. BEAKBANE

A PRELIMINARY study of a small number of varieties of Blackberries, Dewberries and Hybrid Berries has shown that classification work and subsequently the raising of clonal races is needed before any serious research on problems of practical interest such as methods of training and propagation can be successfully carried out. The problem appears to be similar to that already met with at East Malling in the case of other soft fruits such as Black Currants and it is being investigated in the same way.

In the autumn of 1931 the existing collection of three plants each of ten varieties was reviewed and four of the less valuable sorts were grubbed. The six varieties retained were Himalaya Berry (*R. procerus*) the Parsley Leaved or Cut Leaved Berry (*R. laciniatus*), a broad leaved variant from the Parsley Leaved Berry, Sherlock Junior, King's Acre Berry and Phenomenal Berry. The following spring eight more varieties were planted, Youngberry and Lucretia (both dewberries), Lowberry (blackberry × loganberry), Edward Langley (*R. calvatus*), Burbank's Thornless, Blowers, Black Diamond and Wilson Junior. The units of some of the existing varieties were increased from three to six plants. In February, 1933, Hoosac, a thornless variety, was also included. An attempt was made to obtain each of these varieties from several different sources and in certain cases different varieties were received under the same name and in other cases what appears to be the same variety under two different names. This plot is not intended to be used as a variety trial but is being described and recorded in detail so that good plants, true to name and of known history may be used as parents for the clonal races which are being raised. Individual plant records of vigour, cropping, incidence of pests and diseases, period of blossoming and fruiting, time of leaf fall and bud break, autumn colouring, hardiness and suckering are being kept.

The period of blossoming and fruiting records show that, on the whole, berries of dewberry parentage are earlier than blackberry species and hybrids, both in blossoming and fruiting. In addition to these records detailed botanical descriptions of each variety are being compiled.

SUSCEPTIBILITY TO DISEASE.

Two varieties viz. Phenomenal Berry and the Parsley Leaved Berry have proved susceptible to a disease popularly known as Reversion (cause unknown) the chief symptoms of which are severe dwarfing and fasciation of the cane. Sherlock Junior has been seriously damaged each year by a fungus which kills back the cane for a considerable length in spring, namely *Septocytia ramealis* (1). The susceptibility of Loganberries to cane-spot, *Plectodiscella veneta* is well known and our plantation here has been considerably damaged by this disease. In addition to spraying, the possibility of controlling this disease by modified methods of training is being studied in conjunction with the Pathology Section.



FIG. 1.
Diagram of a Leaf of a Common Type of Loganberry.

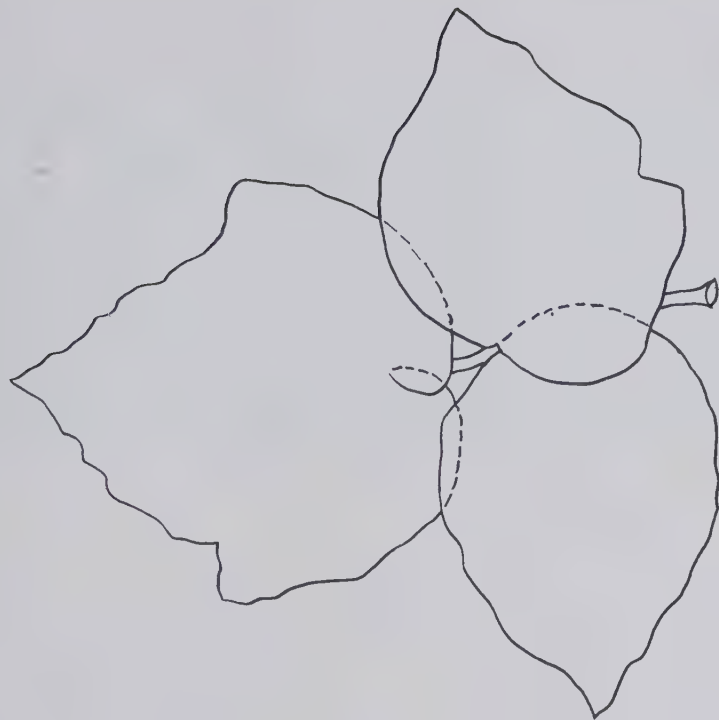


FIG. 2.
Diagram of Phenomenal Berry Leaf.

NOMENCLATURE.

A most striking case of mixed material indicating the need for classification work among berries is provided by a plot of 160 plants at the Station, bought commercially as Loganberries. Just over two-thirds of the plants appear to be identical botanically and were indistinguishable from a variety known in England since about 1910 as Phenomenal Berry. The remaining one-third of the plants consists of forms which are nearly all botanically distinct from each other. These plants, which were found to be distributed at random amongst the Phenomenal Berries, would nearly all pass in commerce as Loganberries although they are probably either directly or indirectly a collection of seedlings. The plants vary in vigour and in colour, waxiness, pubescence and stoutness of cane and in colour, size and distribution of prickles also in the presence or absence of pricklets. The leaves vary in shape, green colour, amount of bronzing, pubescence, serration, pose, dullness or brightness, rugosity and size and also in number of leaflets and in the sinus of the terminal leaflet. The fruit varies in size, shape, colour, pubescence, length of pedicel, cohesion of drupels and time and method of ripening.



FIG. 3.



FIG. 4.

The variation among these plants fully illustrates the statement of Crane and Darlington in their paper *The Origin of New Forms in Rubus* I: "In England the Loganberry is not a clone; this accounts not only for its various appearance but also perhaps for the conflicting reports of its genetic properties. After its introduction it was frequently raised from seeds. The seedlings obtained were not uniform and the plants distributed varied in vigour and in many other characters." (2)

At this stage it will be as well to note that while it will be convenient to continue to refer to the variety known as Phenomenal Berry by that name, the fact must be borne in mind that it may not vary from the group of plants grown as "Loganberries" any more than the members of this group vary from each other. There are two differences, however, between the Phenomenal Berry and the majority of plants grown as Loganberry, which are very easy to observe as well as countless differences which are obvious to the trained eye. Both the Phenomenal Berry and most forms of Loganberry have a terminal leaflet (in leaves with three leaflets) with a deep sinus, but in the case of the Phenomenal Berry the bases of the lobes of the lamina usually overlap and in a great number of the Loganberry types they rarely meet and are often widely separated (see Figs. 1 and 2). Another difference which is very easy to recognize is that whereas most of the fruits of a Phenomenal Berry plant are borne singly most of those of many Loganberry types are borne in pairs (see Figs. 3 and 4).

In addition to a detailed study of the plot of Loganberries referred to above, visits have been paid to a number of growers' plantations. Several cases of varying forms being grown under the common name of "Loganberry" have been recorded and even where a collection of plants in one particular plantation is fairly uniform, they often differ botanically from the "Loganberries" of neighbouring farms. In one case, Phenomenal berries and Loganberries were found to be indiscriminately mixed in a so-called "Loganberry" plantation. The most promising forms of "Loganberry" are being collected and clonal races raised so that they may be compared pomologically. During this work a search has been made for plants resembling as closely as possible the original Loganberry, in order to give some standard in classifying the berries now grown under that name. There are indications that similar cases of admixture occur in other varieties of *Rubus*, for example in the Parsley Leaved Berry, Sherlock Junior and Himalaya Berry. There is considerable variation in the extent of the laciniation (division) of the leaf in plants of the Parsley Leaved Berry. The problem presented by these and other varieties is being investigated in the same way as that of the Loganberry group.

PROPAGATION.

Small preliminary trials of methods of propagation are in progress. The most common method of raising berries in England is by tip-layering and while this is being studied in greatest detail other ways such as layers, cuttings of fruiting laterals, hardwood cuttings, softwood cuttings, "eyes", suckers and root cuttings, a method which is widely used in America, are being tested. With regard to tip-layering, time and method of insertion, time of severing and time of lifting are being studied. These trials will be extended and developed as soon as sufficient clonal material is available.

TRANSPLANTING.

The question of transplanting is also receiving attention. Berries may be planted as tips or as yearling bedded material. When planted as tips the mortality is often very high and yet the use of yearlings adds considerably to the cost of establishing a plantation. From Figs. 5 and 6 it will be seen that tips and yearlings are dependent upon two very different kinds of root systems. The tip plants only possess soft white fleshy roots which are easily broken and which quickly dry out whereas yearling bedded plants possess thickened suberized roots which are able to stand exposure and handling much better. It is also evident that tip-plants possess soft easily injured shoot buds. If these buds are damaged in transplanting the young plants will be badly checked. From this data it seems logical to conclude that where the young plants only have to be moved a short distance and can be rapidly replanted tips are quite suitable but where a long journey is involved yearling bedded material is much safer. The possibility of tip-layering in punnets so as to avoid root disturbance at transplanting as much as possible, is also being explored.

TRAINING.

A preliminary trial of methods of training in relation to cropping and disease factors is in progress and is yielding useful information which will be of great value in planning a future trial on clonal Loganberries. The plot also provides a good practical demonstration of various methods of training.

SUMMARY.

A study of a limited number of varieties of *Rubus* has shown that classification work is very necessary in this group of soft fruits. In the case of several varieties a number of different forms are grown under the same name. The word "Loganberry" has been found to cover so many different forms that it can only be considered as a group name. Clonal races of about fifteen varieties of *Rubus* are being raised.

Reference is made to methods of propagation and training.

It is shown that tip-plants are not fitted to stand exposure and long journeys as well as yearling bedded plants.

ACKNOWLEDGMENTS.

The whole of this work has been done in collaboration with Miss B. Carter and it has merely fallen to the author's lot to write this preliminary report.

We express our thanks to many growers of Blackberries and Loganberries who have kindly given us permission to visit their plantations.

REFERENCES.

- (1) General Review of Research Work. R. V. Harris. *East Malling Res. Sta. Ann. Rep. for 1931*. (May, 1932), 38.
- (2) M. B. CRANE and C. D. DARLINGTON. "The Origin of New Forms in *Rubus* I." *Genetica* IX, 1927, pp. 241-274.



FIG. 5.
Tip-Plant of Parsley Leaved Berry (Broad Leaved Variant).



FIG. 6.
Yearling Bedded Plant of Parsley Leaved Berry
(Broad Leaved Variant).

A SURVEY OF THE WALNUT POSITION IN ENGLAND, 1932

By J. B. HAMOND

East Malling Research Station.

INTRODUCTION.

In 1924 Mr. Howard Spence, of Southport, pointed out the desirability of improving the production of walnuts both in quality and quantity by multiplying trees of known good varieties by vegetative propagation. As a first step towards this end Mr. H. V. Taylor of the Ministry of Agriculture, instituted a Survey of the Walnuts in cultivation in the hope of selecting a few native trees of special merit for further propagation. With the help of the Ministry's Inspectors, samples of ripe, undried nuts were forwarded to Mr. Spence from all parts of the country, in the autumn of 1924. A number of points were taken into consideration in judging the nuts. Good appearance was required combined with good sealing of the shell and a rich flavoured kernel which remained unshrivelled on drying. Many nuts were below their normal standard in 1924 owing to heavy rainfall and lack of sunshine. The survey was repeated with better results in 1925 and 1926, and several trees were selected as bearing promising nuts.

In 1929, after almost ideal weather conditions for walnut growing in this country, the Royal Horticultural Society, assisted by the Ministry, held a most successful Walnut Competition. There were classes for fresh and dry nuts, and over 700 entries were received. As a result of this competition six trees were selected to be kept under observation. Two of these trees are situated in Kent, two in Suffolk, one in Gloucester and one in Worcester.

PROPAGATION.

In addition to propagating from the trees selected by the Walnut Survey and Competition, material has also been collected from the walnut-growing areas in France and California, and, to a less extent, from Belgium, Italy and the East. Scions have also been included from parent trees known to produce the beautiful "burred" walnut wood which is used extensively in cabinet-making. It is hoped that trees raised vegetatively from such material may maintain this characteristic and thus make valuable timber. Experiments in methods of propagation have been carried out at East Malling Research Station by Mr. A. W. Witt.

Up to the present time very little success in budding and grafting walnuts out-of-doors has been obtained in England, and nearly all the collection at East Malling Research Station has been raised under glass. This is chiefly due to the fact that the walnut is very slow to form callus tissue, and in the open the grafts tend to dry out before they have united with the stocks. Experiments are being continued in budding and grafting at intervals over a prolonged season out-of-doors, and in trying different methods of protecting the scions from desiccation. Another reason for lack of success in the open is the difficulty of obtaining good, well-ripened graftwood with a comparatively small pith, especially after a cold, sunless season. Latterly attempts have been made

to overcome this trouble by growing grafted trees of named varieties in a cool greenhouse, where strong woody shoots are produced, and can be used for scion wood.

Grafting under glass can be carried out in March with dormant wood and again in the summer using herbaceous scions. Both these methods have been described in detail by Witt.* Results in 1932 indicate that June is the optimum month for summer grafting. Approximately the same number of grafts were put on in June, July and August, but 66 per cent of the successes were obtained from those put on in June. At present seedling rootstocks, chiefly of the black walnut (*Juglans nigra*), obtained from known parent trees in Canada, are raised for grafting. After one year these are lifted during the winter from the open ground where the nuts were sown, and potted up preparatory to grafting. The stock is cut down within two inches above the soil level in the pot, so that the scion is inserted on the main root or just above it. A union takes place most rapidly if the grafted plants are put in a closed frame with bottom heat of 60° to 70° F. A union also takes place, although more slowly, in plants that are left on the bench after grafting. If the stocks are potted into 4½ inch pots, walnuts can be raised in a small space on a commercial scale by this method.

In 1930 a trouble developed which caused an almost complete failure of the walnut grafts that season. An examination of these grafts revealed the presence of a fungus named *Chalaropsis thielavioides* (hitherto unrecorded on walnuts) which has since been proved by inoculation experiments to be parasitic. This fungus forms a sooty layer of spores between the stock and scion, thus preventing a union from taking place.

After trying out various solutions in the laboratory, it was found that formalin at a strength of 1 per cent is toxic to the fungus spores, so in the last two seasons the propagation house, where the walnuts are raised, has been thoroughly sprayed with 1 per cent formalin before the grafting season commenced. As a result of this treatment, the fungus has almost disappeared and 91 per cent success with first-class material was obtained last spring.

Grafted walnuts are removed from the closed frames after about three weeks. In normal cases a union will have taken place during this time, and new growth will have appeared. The plants are hardened off on the bench during the summer, where they are exposed to plenty of light and air. They grow quickly, and frequently make 1 to 1½ feet of strong, new growth by the beginning of July. They are planted out in the nursery about the end of August. During the next two or three years the tips of the side shoots are pinched off during the growing season and the trees are run up to a single straight stem. When they are about 5 ft. high they are transplanted to permanent positions.

ROOTSTOCKS.

Although seedling rootstocks of *Juglans nigra* are at present used for most of the walnut grafting, some vegetatively raised rootstocks are being used on an experimental scale this spring. Walnuts do not root freely from cuttings or layers, but several selections of *Juglans* species are being tried out. Hybrids between *J. regia* × *J. californica* and *J. nigra* × *J. californica*, known respectively as "Paradox" and "Royal" hybrids, have consistently rooted more freely than any other selections. Some selections of *J. regia* and some hybrids have not yet given satisfactory rooting on the layers. This is probably due to the very strong growth made in the early life of the stools. There is reason to expect better rooting as the stools become older and the vigour of the annual shoots is reduced.

* "The Vegetative Propagation of Walnuts." *Ann. Rep.* II, 1926-27.

"Further Notes on Walnut Growing in England." *Journ. of the R.H.S.*, Vol. LV, 1930.

In the spring of 1932, all the layers were treated with a mixture of spent hops and sand in the first two earthings, to see whether freer rooting would result. On opening up the stools in November, 1932, good roots were often found in association with spent hops. This treatment will be repeated this spring.

Layers rooted three years ago are now developing vigorous growth comparable with seedlings. Therefore it seems probable that varieties of walnuts grafted on vegetatively raised rootstocks will be as vigorous as those on seedling rootstocks, with the added advantage of having a known constitution.

SELECTION OF VARIETIES.

At the end of 1931, some 624 walnut trees had been raised vegetatively at East Malling. These trees consisted of about sixty-four varieties collected from all over the world. Two trees of each of these varieties have been planted in permanent positions at East Malling and two of each variety at Mr. Spence's farm at Kirdford, in Sussex. Observations will be made on their time of leafing-out, type of growth, resistance to disease and, finally, on the quality of the nuts produced. Graftwood from any that prove outstandingly good in this country will be available from these two sources to build up a stock. Many of these varieties have already proved unsuitable for cultivation in this country on account of very early leafing-out and consequent damage by our early spring frosts. This is found particularly to apply to varieties from Persia and the Far East. Other varieties have been eliminated on account of great susceptibility to bacterial blight or die-back due to frost injury.

In the autumn of 1931 twelve varieties which bear nuts of outstanding quality were selected as being especially suitable for our climatic conditions. These are being rapidly propagated. Seven established English trees were chosen, five of which were outstanding at the Walnut Competition. The tree which bore the first prize winning nuts in the "Fresh" Class is situated in a small orchard at Ixworth, in Suffolk. As would be expected, these nuts reach a very high standard and combine all the good qualities mentioned earlier. The shells are remarkable in that they are very smooth and lacking in well-marked indentations. This characteristic adds considerably to the ease with which an unbroken kernel may be obtained on cracking a nut.

Another tree which is situated in Suffolk, near Ipswich, bears nuts of such exceptionally good appearance that they were awarded a special prize at the Walnut Competition. These nuts gained full marks for external characters, as they are of excellent size, weight and colour and are very well sealed. They would sell particularly well on account of their attractive appearance. Unfortunately, the kernel is not proportionately large, but, as the percentage of oil present is above the average, it remains unshrivelled on storing. The tree is only about 20 ft. high and not more than about 25 years old.

Another sample of good looking nuts was received from Dartford. They were borne on a tree growing in a small private garden. The tree is about 50 years old and appears to be in excellent condition, it bears a good crop every year. The nuts are exceptionally well filled and remain so on storing.

Trees bearing the large type of walnut known as a "Double" nut are not usually of value for propagation, as these nuts have the disadvantages of being badly sealed and containing very small kernels in spite of their large shells. An exception to this rule is seen in the nuts borne on a young tree in Margate. Nuts from this tree were entered in the Walnut Competition and aroused much interest when it was found that their large shells contained a proportionately large kernel. Although the nuts are not outstanding in flavour, their appearance and filling were thought sufficiently remarkable to merit the parent tree being included among those for rapid propagation.

Lastly, a tree growing in an orchard about eight miles out of Gloucester was chosen as a result of the competition. The nuts from this tree were awarded the first prize in the class for Dried Nuts. They are rather small in size but extremely well filled and contain the highest percentage of oil of any nuts that were selected.

The other two selected English trees bear small nuts in large grape-like clusters and are therefore very suitable for pickling. One tree is situated in Sussex, and one near Maidstone, in Kent. Samples of nuts from these trees have been tested by two leading London firms and proved to be very satisfactory for pickling purposes.

In addition to these English selections, four French varieties, Franquette, Mayette, Meylanaise and Treyve, have been chosen and one American variety named Woodland. The latter, in addition to bearing nuts of outstanding quality, also bears catkins during the first few years. Most grafted trees bear nutlets only during the first five years, and they mature only if they are fertilized by pollen from an older tree. After this time both types of flowers are borne on grafted walnut trees. Seedlings are reputed to come into cropping considerably later. On account of its precocity in bearing catkins, the variety Woodland should bring about early cropping if planted up with other young walnut trees.

All the twelve selected varieties leaf out late in the spring. There are two reasons for choosing varieties that are late in leafing-out for propagation in this country. Firstly, such varieties should escape damage to the foliage and nutlets by our early spring frosts, and, secondly, the unopened buds are incapable of being attacked by the bacteria which cause walnut blight. These bacteria are readily disseminated in the fogs and mists that are characteristic of early spring in this country, and exude from old lesions, attacking all young, growing parts of the tree. The disease is usually noticed first as black spots on the leaves. It spreads from these to the young stems and nutlets, causing the latter to fall when they are very small. During the winter bacteria have been isolated from the bud-scales* as well as from stem lesions, this being so, the disease cannot be eliminated merely by cutting out the stem lesions. Hitherto spraying experiments have been of a rather preliminary nature, as it has been necessary to use many different varieties grafted on several different rootstocks. A good control of the disease has been effected at this Station by applying a protective spray of Bordeaux mixture at a strength of 8-8-100 immediately the trees have leafed out and before attack has taken place. If the summer is wet this is followed up by two or more applications of Bordeaux mixture at 8-25-100.

OBSERVATIONS ON SELECTED TREES.

The cause of persistent lack of cropping in a walnut tree is usually due to the fact that the catkins and nutlets are not ripe at the same time. This difficulty can be overcome by planting up several trees of different varieties, in order that pollen may be present over a longer period, thus resulting in fertilized nutlets. Having selected trees for rapid propagation in this country, observations have been made from year to year in order to find out whether these trees are self-pollinated. In every case the pollen was found to be ripe when the stigmas were receptive. This being so, any grafted trees raised from these parent trees will also be self-pollinated and so may be planted up separately.

As the selected English trees have been chosen primarily on account of the high quality of their nuts it is important to ascertain that this high standard is maintained. With a view to this end the percentage of oil present in samples of nuts from each tree

* "Some Diseases of Walnuts." *Ann. Rep., II. Supplement*, 1930.

has been estimated during the last three years. A rich flavoured nut which remains plump on storing is one which has an oil content of about 50 per cent or more. An average nut only contains about 30 per cent to 40 per cent oil, and a proportionately high percentage of moisture, hence the flavour is insipid, and on storing most of the moisture evaporates leaving a shrivelled kernel. In these experiments the oil is extracted in ether, the nuts used having previously been dried in an atmosphere free from oxygen. The results have not varied more than 2 or 3 per cent from year to year. On the whole the oil contents were slightly lower after the wet seasons of 1930 and 1931 than after 1932, but, with one exception, the oil content was over 50 per cent in every case. The exception was found in the case of the double nut from Margate, which had an oil content of 48 per cent in 1931.

DISTRIBUTION.

In the autumn of 1931 twelve varieties, including most of those selected for rapid propagation, were planted up in six localities across the South of England. These varieties were also included in the complete collections placed at East Malling and at Mr. Spence's farm in Sussex, so they were planted at eight centres in all. Data will thus be available on the same twelve varieties growing under different soil and climatic conditions. The following localities are represented :—

East Malling, Kent.
 Faversham, Kent.
 Sutton-at-Hone, Kent.
 Halstead, Essex.
 Kirdford, Sussex.
 Lakenheath, Suffolk.
 Salisbury, Wiltshire.
 Minehead, Somerset.

In addition to these experimental sets of trees, small numbers of grafted walnut trees were also available for distribution to growers. A ready demand was found for them, and, in all, 274 trees were sent out from this Station during the last two seasons. Next season a larger number of trees will be available, and it is hoped that having now commenced to distribute them, it will be possible to keep up the supply from year to year. With this end in view, a special effort is being made to propagate the twelve selected varieties in large numbers.

HARVESTING AND STORAGE.

In France and California, where walnuts are grown on a commercial scale, the crops are always systematically cleaned and treated with a bleaching agent before they are sold. Experiments in the treatment of nuts after harvesting and in various methods of storage for winter use, are now being carried out at this Station.

Walnuts are harvested from the ground. It is important to remove the shuck before it becomes black and sodden, as this causes the nuts to become discoloured and encourages the growth of moulds. If the trees are shaken regularly during the harvesting period the shuck, although easy to remove, will still be green and firm when the nuts fall to the ground. It has been found quite useless to attempt to store badly sealed nuts as the kernels quickly become shrivelled and also moulds pass easily between the two halves of the shell and attack the kernel.

After harvesting the nuts, the crevices in the shells must be cleaned from every trace of shuck, as it is there that moulds commence to grow. Mechanical washers are used for this purpose where walnuts are grown on a large scale, but scrubbing with a

damp brush has been found quite effective. After cleaning, the nuts are allowed to dry in a single layer before bleaching. A bleaching solution prepared from chloride of lime and soda has been found most effective for improving the appearance. Nuts so treated are more resistant to moulds and take on the attractive light colour characteristic of the American nuts.

Before storing, the nuts may be further dried by heating at 80° to 110° F., until no more moisture is lost. This treatment makes them much more resistant to moulds and results in a richer flavoured kernel, but the attractive crispness of a fresh nut is lost.

Two factors must be considered in selecting a suitable place in which to store the nuts, firstly the temperature and secondly the humidity of the atmosphere. Under cold storage conditions, i.e. at a temperature of 38° F. and relative humidity of 90 per cent, nuts have been found to keep plump and free from moulds without any storage medium. If the temperature is raised to about 45° F. and the relative humidity is kept at 90 per cent, these being average readings in a cellar during the winter, the nuts keep plump, but a storage medium is required to prevent the growth of moulds. If the relative humidity of the atmosphere is lowered to between 70 and 80 per cent and the temperature is kept at about 45° F., nuts under these conditions are found to shrivel somewhat, but they are very little attacked by moulds, even in the absence of any storage medium. As cold storage conditions are not usually available the problem has been to find a suitable storage medium in which to keep nuts under cellar conditions.

Common salt is the best fungicide that has yet been found in these trials, but its disadvantage as a storage medium lies in the fact that it takes up moisture from the atmosphere and hence makes the nuts very wet. Recently an attempt has been made to counteract this disadvantage by mixing the salt with coco-nut fibre or sodium phosphate, both of which tend to absorb moisture taken up by the salt, without impairing its fungicidal properties. Earthenware crocks are filled with alternate layers of nuts and the storage medium until they are full. The crocks are then kept in a cellar during the winter. Walnuts have been successfully stored by this method until the following spring.

FUTURE WORK.

It is felt that it is now possible to work on a definite programme of rapid propagation, as outlined above, in order to meet the increasing demand for grafted walnut trees in the British Isles. Enquiries for these trees have also been received from Australia, South Africa, Denmark and Palestine and scion wood of certain varieties that do well under Californian conditions is now being produced here. From this material it will be possible to raise trees suitable for growing in warmer climates which will meet the demand from the Dominions and elsewhere.

SUMMARY.

The desirability of improving the production of walnuts in this country is stressed. This work has been commenced by multiplying trees of good varieties by vegetative propagation. The propagation question is discussed, with special reference to rootstock problems.

The characteristics of a good nut are mentioned as a guide to selecting varieties for rapid propagation.

Pollination problems in walnuts are briefly discussed, and oil content determination work on nuts from selected trees is described.

Mention is made of the fact that young grafted walnut trees have been distributed to growers during the last two years.

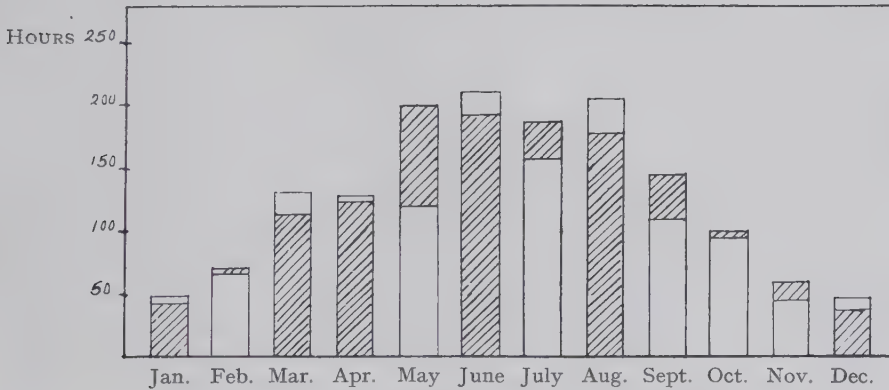
Finally, successful methods of bleaching, curing and storing walnuts during the winter are described.

WEATHER CONDITIONS DURING 1932

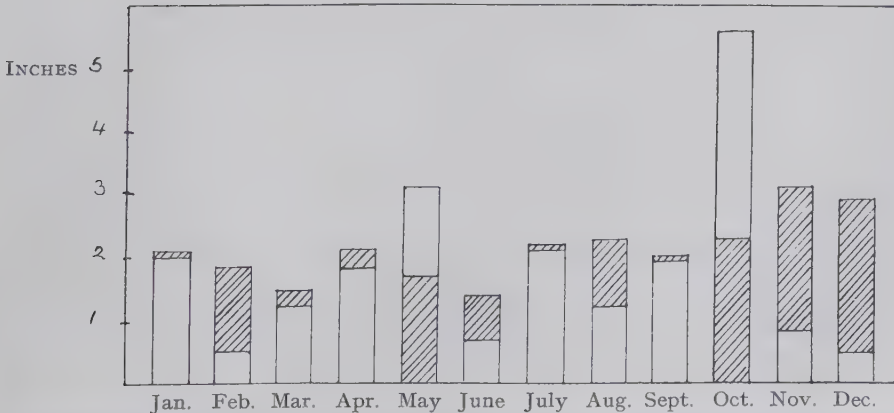
By H. C. CHAPELOW AND H. M. TYDEMAN

TAKEN as a whole, the past year has been a somewhat dry one. Certain months, notably February, June, November and December were outstandingly dry and, in the case of the drought during June, crops suffered to some extent in consequence. The year's total of 21.5 inches was over 4 inches below the 17 years average here. Sunshine was deficient also, the year's total of 1,372 hours was 83 hours in defect of the normal. Practically the whole of the year's deficiency occurred during May which was extremely dull. Temperatures followed an approximately normal course. May was somewhat cooler while August and October were rather warmer than usual. Uncongenial conditions during the earlier part of the year retarded the blossoming of most varieties of fruit. As a consequence, varieties were in blossom together and their setting was also favoured by the absence of spring frosts. Good crops of apples, pears and plums were obtained. Mild conditions during the late autumn proved ideal for the ripening and harvesting of fruits. Raspberries were being picked at the end of November and leaf fall was also considerably delayed. These conditions also favoured planting and spraying operations during the earlier part of the winter.

TOTAL SUNSHINE IN HOURS.



TOTAL RAINFALL IN INCHES.



Diagrams showing Total Sunshine and Rainfall during 1932 as compared with previous 17 years' average. Shaded portion 17 years' average.

SUMMARY OF METEOROLOGICAL OBSERVATIONS DURING 1932.

	TEMPERATURE IN SCREEN.				No. of GROUND FROSTS.	RAINFALL.			SUNSHINE.		SOIL TEMPERATURES.			
	Mean Maxi- mum.	Mean Mini- mum.	High- est.	Low- est.		Mean.	Total in inches.	17 years' average.	Heaviest fall in a day.	Total hours.	17 years' average.	Average per day.	4 inches.	8 inches.
JANUARY	48.7	35.7	57	18	42.2	2.06	2.24	0.53	49.6	47.9	1.6	40.5	41.4	42.9
FEBRUARY	41.7	31.1	50	22	36.4	0.46	1.85	0.19	66.8	68.7	2.3	36.5	37.3	39.5
MARCH	47.6	32.6	54	19	40.1	1.15	1.46	0.35	132.7	115.8	4.3	36.8	37.7	39.6
APRIL	52.0	38.8	64	31	45.4	1.81	2.16	0.29	128.9	126.1	4.3	45.0	44.2	44.8
MAY	59.2	43.7	72	31	51.5	3.06	1.76	0.70	121.0	196.4	3.9	52.1	51.4	51.7
JUNE	66.8	46.5	79	35	56.7	0.69	1.36	0.58	205.7	198.4	7.0	58.3	57.8	57.7
JULY	70.8	52.4	82	43	61.6	2.12	2.21	0.59	157.0	183.0	5.1	64.4	63.6	64.1
AUGUST	75.2	55.2	90	47	65.2	1.26	2.26	0.39	213.9	178.3	6.9	65.8	65.3	65.4
SEPTEMBER	65.3	49.4	76	36	57.3	1.97	2.02	0.47	107.6	145.0	3.6	60.0	60.3	62.5
OCTOBER	55.6	41.4	64	32	58.5	5.60	2.56	0.94	96.5	100.0	3.1.	49.6	50.5	53.5
NOVEMBER	49.4	38.6	59	28	44.0	0.82	2.98	0.32	43.0	57.0	1.4	44.2	45.0	47.4
DECEMBER	46.3	36.0	56	26	41.1	0.44	2.79	0.14	46.1	38.6	1.5	39.6	40.3	43.2

MYCOLOGY AND BACTERIOLOGY

NOTES ON PLANT DISEASES IN 1932*

By H. WORMALD AND R. V. HARRIS

IN 1932 plant diseases in their prevalence and intensity differed in certain marked respects from those observed during the previous year.† The cold wet spring favoured the development and spread of such diseases as apple and pear scab, brown rot blossom wilt; and grey mould. Potato blight was widespread, and blight in tomatoes appears to have been more destructive than usual. The dry periods during summer checked these diseases to some extent but later brown rot of fruit and various "functional" diseases of apples and pears (e.g. cork, bitter-pit and glassiness) caused serious losses. Bitter pit in apples was unusually severe, as shown by its frequent appearance on fruit exhibited at shows. Cases of apples of apparently high quality were rejected because of the presence of pit.

Tomato Blight.—In the middle of August as Potato Blight was threatening to be destructive two instances of severe infection of tomatoes were brought to our notice. A Sussex grower, who sent specimens showing the foliage and fruit badly blighted, wrote: "We have planted out in our market garden about 4,000 tomato plants; they all have signs of disease as enclosed specimens." The fungus causing tomato blight is *Phytophthora infestans*, the potato blight organism, though some workers consider the forms on the two host plants to be different biologically.

During wet summers tomato plants in the open should be kept under close observation and on the first appearance of blight the plants should be sprayed immediately with Bordeaux mixture before the disease has assumed serious proportions.

Apple and Pear Scab (*Venturia inaequalis* and *V. pirina*).—The severity of scab infection in 1932 was mainly a result of the unfavourable weather conditions at the time the trees were coming into bloom. The flowers opened very gradually, with the result that where spraying was delayed until the "pink-bud" stage, infection had already started and the treatment did not yield the same measure of protection that had been obtained by one pre-blossom spray in previous years. On 5th May small scab spots were found on the rosette leaves of Cox's Orange Pippin and James Grieve, before the trees had reached the pink-bud stage. It is evident that in seasons when the blossoming period is delayed two pre-blossom sprays are essential for good control of scab.

On a plot of Louise Bonne cordon pear trees on a farm in North Kent there were many spurs bearing withered flowers and leaves. The bark of such spurs was cracked and scab pustules were found in the cracks. The canker fungus (*Nectria galligena*) frequently attacks pear spurs and branches through scab lesions, and this was thought to be another case of such infection. No evidence of the presence of the canker fungus could be found however and it was concluded that the damage was due solely to severe scab infection. From the appearance of the lesions infection must have taken place

* Reprinted from the *Gardeners' Chronicle* (18th March, 25th March, and 1st April, 1933) by permission of the Editor.

† See the *Gardeners' Chronicle*, 12th March, 1932, p. 207, and 19th March, p. 224.

during 1931; the lesions did not prevent the buds from growing out, but when the flowers and leaves were fully expanded they wilted.

Brown Rot Diseases.—Blossom wilt caused by the brown rot fungus *Sclerotinia cinerea* was very prevalent on cherry, plum and apple trees. The Lord Derby apple is particularly susceptible to blossom wilt and in the eastern and south-eastern counties this variety suffered severely, the trees in some plantations being rendered almost barren by the destruction of the blossom.

Later in the season there was much rotting of fruit by *Sclerotinia fructigena*. An instance of brown rot destroying apples on the market within a few days after they were picked has already been recorded*; the apples showing infection had been picked without stalks and the fungus had entered through the wound left at the stalk end.

Grey Mould.—In wet seasons Grey Mould (*Botrytis cinerea*) is usually to be found without difficulty on a number of plants. In 1932 we found it on apple roots, leaves of sweet cherry and Morello, plum (shoot), gooseberry (fruit), lilac (shoots), violets (destroying the foliage), and strawberry (fruit). In some cases the infection of strawberries was severe. *Botrytis elliptica* was again found associated with wilting in Lilies.

The occurrence of *Botrytis cinerea* on apple roots is of special interest, for this fungus is not often found on the woody parts of plants and not, as a rule, underground. In this instance it was found on one-year-old bedded stocks that had been removed from the stools as layers in the winter of 1930-31, and bedded out. In October they were lifted, collected into bundles and again bedded in the ground. When lifted in January, 1932, many of the roots were found to be rotting and bearing fructifications and sclerotia of *Botrytis cinerea*. The particular variety of stock (East Malling No. 7) produces fibrous roots in abundance and these probably retained a superabundance of moisture when bunched together and bedded in the soil during wet weather. Other varieties of stocks that had been similarly treated were free from Grey Mould.

Wilt Diseases caused by Verticillium.—In our previous "Notes" we mentioned finding *Verticillium dahliae* in the woody tissues of dying branches of the Morello cherry. This fungus is known to attack very many herbaceous and wood plants and the number of host plants is increasing yearly. In 1932 we found it in the tissues of wilting lupin plants, in diseased branches of black currant, and in quince layers. In each case discoloured sectors in the wood yielded *Verticillium dahliae* on transferring sections of the wood to culture plates. In the quince the fungus was associated with the wilting of shoots that were being raised from layers as stocks for pears. This appears to be the first record of *Verticillium dahliae* on quince.

The disease on quince is of particular interest in relation to the propagation of pear trees worked on quince stocks. During the summer many young pear trees on quince stocks† growing in nursery rows failed altogether or the foliage turned yellow and withered during the summer. On examining a number of these trees discoloured sectors were found in the wood of the stocks and again *Verticillium dahliae* was isolated from the discoloured tissues. As this fungus was present in the layers and also in the stocks of the young trees it appears possible that some of the stocks were already infected when planted out for working.

Lilac Bacterial Blight.—A destructive disease of lilac bushes occurring at Marlborough in June, 1932 has already been described.‡ The symptoms resembled those

* *Gardeners' Chronicle*, 10th Sept., 1932, p. 200. See also this Report, p. 137.

† The stocks in question were Malling types A and C.

‡ *Gardeners' Chronicle*, 13th August, 1932, p. 116.

of Bacterial Blight of lilacs as found on the Continent and in North America. This appears to be the first authentic record of such a bacterial disease of lilacs in Britain. The organism has been isolated and is being studied in culture (for its identification) side by side with a Holland strain and with two American strains kindly supplied by Miss Mary K. Bryan of the United States Department of Agriculture. So far as the tests have gone the organism appears to be *Pseudomonas syringae*, the cause of Lilac Blight, although the Marlborough organism shows some divergence from the type in certain respects.

The identification of the organism is of interest, for recent investigations in America have shown that *Pseudomonas syringae* is very closely related to, if not identical with, the Citrus "Blast" organism (*Bacterium citriputae*) and *Bacterium cerasi*, an organism which infects cherry trees in America. Whether the organism found on lilacs in this country is able to infect stone fruit trees is a problem that remains for further investigation.

Quince Leaf Blotch.—In 1931 the infection of quince leaves by *Sclerotinia cydoniae* was slight but in 1932 the conditions in spring were more favourable for the development of the fungus and Leaf Blotch was conspicuous on some of the varieties growing on the "Museum" plot at East Malling, although the trees had been sprayed with Bordeaux mixture soon after the leaves unfolded. In many cases not only were individual leaves infected but the infection passed into the young shoots themselves causing them to wilt. Three of the trees each bore over a hundred infected leaves and withered shoots.

Sooty Blotch.—This disease attributed to the fungus *Gloeodes pomigena* was more prevalent than usual in 1932 probably as a result of the wet weather in late summer and autumn. It was found on apples, pears and plums. Warwickshire Drooper plums were again found infected and the fungus was also found on Victoria and Pond's Seedling plums.

As a rule Sooty Blotch is not sufficiently serious in this country for any special steps to be taken against it. In 1932 however it was in some cases conspicuous enough to detract from the appearance of otherwise sound fruit. The fungus is more superficial than the scab fungus and can be rubbed off without any great difficulty, leaving only a slight trace of damage to the skin. Many apples were seen exhibited at shows that had either Sooty Blotch actually on them or they showed evidence that they had been infected and that the fungus had been rubbed off. One grower in East Kent reported severe Sooty Blotch on his Bramley's Seedling apples. In fifty or sixty boxes about 50 per cent had to be cleaned (by wiping with a damp cloth) before they could be marketed.

A Disease of Common Mussel Plum Stocks.—About the middle of August our attention was drawn to the wilting of shoots in the layer beds of Common Mussel stocks. On making an examination it was found that near the base of each affected shoot there was present, on the underground part, a constricted portion, one to two inches long, where the bark bore dark dots that appeared to be fungal fructifications. These bodies however did not produce spores and were evidently of the nature of microsclerotia. The absence of any definite fructifications and the presence of those sclerotia suggest that the fungus is a species of *Rhizoctonia*. The fungus has been isolated in culture but inoculation experiments to test its parasitism have not yet been carried out.

Raspberry Mosaic-disease.—During the year an unusual number of cases of failure of Lloyd George plantations have been brought to our notice and have provided striking additional evidence of the progressive deterioration of the ordinary commercial supply of cane of this variety. This state of affairs is particularly serious in view of the present exceptionally heavy demand for Lloyd George berries for canning purposes.

A series of experimental cane-nurseries planted on selected farms in Kent and Sussex for raising commercial supplies of Mosaic-free Lloyd George cane, yielded their first main crop of cane this year. In health, uniformity, and vigour of growth, this cane was comparable with the Lloyd George plantations of ten years ago and contrasted strikingly with the uneven and depleted growth of the commercial plantation of the present day. Evidence was thus provided that the degeneration of the Lloyd George raspberry is mainly due to the hitherto unchecked spread of Mosaic-disease in the variety, and the remedy is therefore bound up with Mosaic-control. The method by which this may be achieved, namely by planting nurseries specifically designed for raising virus-free cane, is indicated by the initial results of the experiments referred to above.*

The importance of assessing the susceptibility to Mosaic of a newly introduced variety, and of making an early start in segregating a Mosaic-free race of canes, has been emphasized this year in the case of the recently introduced and exceptionally vigorous and promising "Preussen" variety. In 1931 isolated cases of infection were observed in young plantations at the Research Station and elsewhere, but such cases, although well defined, were but rarely met. This year, however, a very high proportion of the stools of these plantations developed Mosaic symptoms and it was evident that the vigour of such stools was greatly reduced. Fortunately a clonal race of Mosaic-free cane had already been isolated in the nursery beds at the Research Station. Otherwise the selection of initial stools for propagation would have been an extremely difficult and tedious matter.

Raspberry Cane-Spot and Spur-Blight.—The damage caused by these diseases this year was of an unusual nature. This was undoubtedly correlated with the exceptional weather experienced during the critical months in which the main stages of development of the fructifications of the fungus responsible for each of these diseases takes place, i.e. April to June.

In the case of Cane-spot (*Plectodiscella veneta*) the effect of this was to delay the main wave of infection until the time of berry-formation. A direct infection of the immature berries consequently took place with the result that a varying proportion of the mature fruits were badly deformed.† This year the major effect of the disease has therefore consisted in direct injury to the current year's crop and not, as is more usual, in injury to the young canes, and a resulting reduction of next year's crop. Such damage was observed only in unsprayed plantations and this fact further emphasizes the necessity for a regular annual routine spraying against Cane-spot. Under similar seasonal conditions such spraying would materially increase the amount of saleable fruit produced during the same year and by reducing injury to the young canes would also increase the cropping power of the plantation the following year.

The effect of these exceptional weather conditions on Spur-blight (*Didymella applanata*) infection was observed in the first instance in a Lloyd George plantation in East Sussex‡ and was precisely the reverse of that on Cane-spot. In this case the initial wave of infection occurred exceptionally early and before the fruiting laterals had completely matured, with the result that they were seriously injured, in many instances killed, and the current year's crop greatly reduced. This is the first instance observed by the writers where an attack of Spur-blight alone has led to serious economic consequences.

* Practical details as to the planting and conduct of such nurseries will be gladly supplied to growers on application to the East Malling Research Station.

† For a detailed account of this form of Cane-spot injury see this Report, p. 86.

‡ We are indebted to Mr. G. C. Johnson, Horticultural Superintendent for East Sussex, for drawing our attention to this form of injury.

A further feature of interest during the year has been the striking evidence provided that the Lloyd George variety is becoming increasingly susceptible to Cane-spot. Three years ago this variety was included in the class of those not seriously affected by the disease. Infection spots were commonly observed on Lloyd George canes but the attack was never sufficiently serious to cause an appreciable reduction in crop. In 1931 our attention was called to a Lloyd George plantation in this neighbourhood in which it was clear that the disease had seriously affected the normal growth of the fruiting cane. This was the first attack of economic importance to be observed by the writers on this variety and as no similar cases were discovered during that year it was regarded as probable that the situation of the plantation was exceptionally favourable for infection. This year, however, Lloyd George cane in widespread districts (including the Scottish raspberry growing areas) was very severely cankered by the disease and its growth in consequence seriously impeded. There is therefore no longer any doubt that this variety must now be included in the class to which routine spraying control-measures should be applied.

"Strawberry Yellow-edge" Disease.—In our previous "Notes" it was stated that an investigation had been commenced at East Malling into the causes of a serious degeneration of Royal Sovereign plants in certain local plantations and on the trial plots at the Research Station.

Experiments carried out in 1931 and during the present year have indicated that this degeneration is primarily the result of infection by a virus which, once it is introduced into a plant will, even in the absence of mite and insect infestation, bring about in that plant and its runner-progeny a rapid loss of vigour followed by complete sterility and death.* The name "Yellow-edge" is proposed in order to distinguish the disease from the analogous diseases in America known as "Yellows" and also from Mite-plant, a symptom of which is a uniform yellowing of young leaves.

A very high percentage of plants infected with Yellow-edge was found in many Royal Sovereign plantations examined during the year. In other plantations cases of infection were very rare and their uniform vigour and high productiveness contrasted strikingly with the patchy and generally poor condition of the more seriously infected plantations. It is clearly a matter of extreme importance that in planting up Royal Sovereign (and other susceptible varieties) the greatest precautions should be taken to ensure that the supply of runners used is free from cases of virus-infection.

SUMMARY.

A survey is given of the more notable plant diseases observed during 1932. Of special interest are Grey Mould of apple roots, *Verticillium* wilt of quince stocks, a *Rhizoctonia* wilt of Common Mussel plum stocks, and the Yellow-edge disease of strawberry plants.

* A detailed account of these experiments and of the disease and its symptoms has recently appeared in the *Journal of Pomology and Horticultural Science*, 1933, **11**, 56-76.

THE INFECTION OF RASPBERRY FRUITS BY THE CANE-SPOT FUNGUS

By R. V. HARRIS

I. INTRODUCTION.

In the original description of Anthracnose on the Black Raspberry in America Burkholder (2) refers to the infection of canes, petioles, pedicels, and leaves but does not mention an infection of the fruits. More recently Leon Jones (4) and Berkeley (5) recorded fruit infections, but owing to their comparatively rare occurrence no detailed description of the symptoms was given. In this country the present writer (3) has recently described symptoms of direct attack on the canes, petioles, leaves and fruiting laterals of the red raspberry. The reduction in yield of susceptible varieties due to the disease was stated to be mainly the result of the infection of the canes (not of the fruit or laterals) in their early stages of growth (i.e. in the early part of their first year). Until 1932 no direct infection of the fruit had been observed. In 1932 enquiries were received from widespread localities, including the Scottish raspberry growing area, as to the cause of a serious deformation of the fruits of certain varieties (*Baumforth Seedling B* in particular).* On examining the Research Station plantations of these varieties a large proportion of the fruits was found to show the same symptoms. On these fruits minute fungous fructifications (acervuli) were present. On touching the acervuli with the point of a needle and then introducing it into a drop of sterile water a concentrated suspension of unicellular hyaline spores was invariably obtained. The spores closely resembled the summer (*Gloeosporium*) spores of the cane-spot fungus (*Plectodiscella veneta*). Dilution plates were poured using drops of the spore suspension prepared in this way, and in every case they yielded pure cultures of a fungus indistinguishable from type cultures of *Plectodiscella veneta* isolated from cane lesions. It was concluded therefore that the deformation of the fruits was due to the retarded development of one or more of the drupels that had become infected in an immature condition with the cane-spot fungus.

2. SYMPTOMS.

In most cases infected drupels were grouped together. A typical infected fruit consequently, had a one-sided appearance when ripe (Fig. 1). On one side it appeared normal but on the other a group of the drupels was immature, dwarf and green. Every degree of deformation was observed depending (a) on the number of drupels infected and (b) on the stage of development reached when infection took place. Thus some berries infected slightly just before ripening were normal in appearance except that two or three of their drupels were slightly smaller and paler in colour than their neighbours. Such a case of slight infection is shown in Fig. 2. In extreme cases where heavy infection

* The writer is indebted to Mr. G. C. Johnson, Horticultural Superintendent for East Sussex who first drew his attention to this form of fruit-injury and pointed out its association with Cane-spot disease.

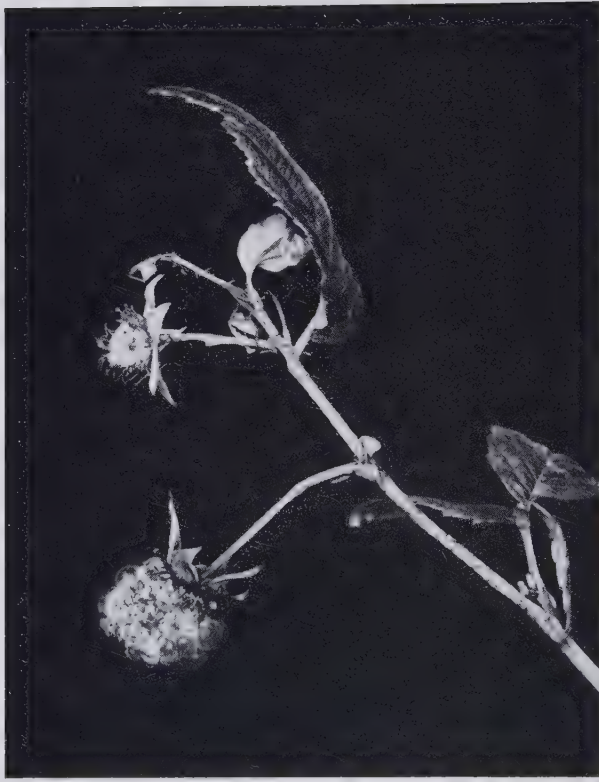


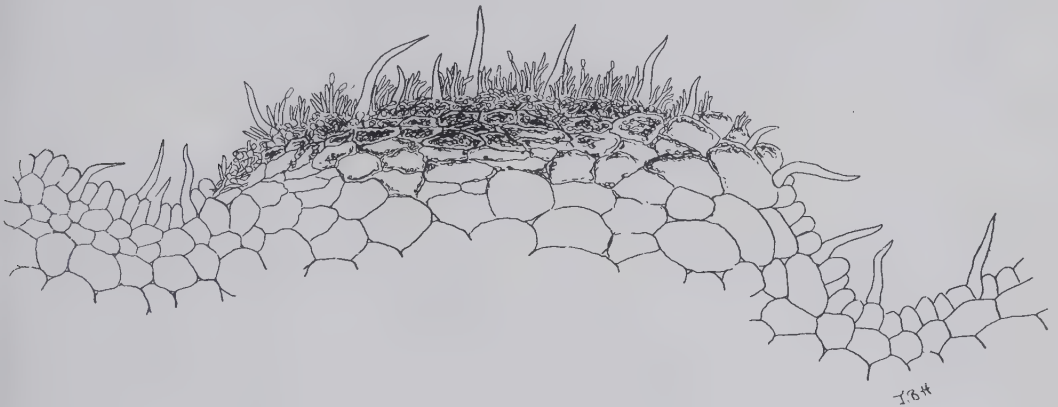
FIG. 1. A severely infected lateral and fruit of *Baumforth Seedling B*, showing "pit-lesions" and "superficial-lesions" on the lateral, and acervuli on the infected drupels. Photographed on 24.8.32. Nat. size.



FIG. 2. A fruit of *Baumforth Seedling B*, slightly infected at a late stage of development, showing acervuli and retarded drupel-development. Photographed 24.8.32. ($\times 3.5$.)

had taken place soon after fertilization, a large part of the fruit at maturity consisted of minute dry and withered drupels.

Except in extreme cases of early infection (as described above), one or more minute fructifications of the cane-spot fungus were clearly visible with the naked eye on every infected drupel. Each was slightly raised on a little mound of pericarp tissue and the tissue immediately outside this mound was slightly sunken (see Fig. 2). These fructifications were circular and varied from 0.3 to 1 mm. in diameter, the average being 0.6 mm. They were light brown in colour and were clearly visible although their outline was somewhat blurred by the normal fruit pubescence (Fig. 2). Their structure in section is shown in the text figure.* Conidiophores or spore-bearing branches are produced freely from the acervulus, from which the summer or *Gloeosporium* spores are abstracted in large numbers. It will also be seen that the acervulus pad replaces the epidermal layer of cells and that it is raised above the surrounding tissue on a stromatic cushion consisting of pericarp cells permeated by fungal hyphae.



A transverse section of a portion of the pericarp of an infected drupel taken through a fructification of the cane-spot fungus ($\times 100$).*

3. THE RELATION OF FRUIT-INFECTION TO WEATHER CONDITIONS.

In August, 1932, the canes of varieties showing the fruit-infection described above were examined. On the new canes the severity of the attack of cane-spot was found to be exceptionally slight. Numerous lesions were present but these were mainly of the "superficial type" (the result of infection from late July onwards). On the fruiting canes the laterals and pedicels were heavily spotted, but the lesions on the laterals were again mainly of the "superficial" type. These observations confirmed the conclusion suggested by the heavy infection of the berries that in this season the main wave of ascospore infection instead of taking place as normally, before the blossom period and during the initial stages of growth of the current year's canes (i.e. from late April till the end of May) was delayed until after the fruiting laterals were fully grown and took place while the fruits were maturing.

It has been shown elsewhere (3) that the degree of injury caused by the infection of the young canes depends on the time at which the main wave of infection takes place and that this is largely determined by the weather conditions prevailing from April till July. The greatest injury is caused when this infection takes place in late

* The writer is indebted to Miss J. B. Hamond for this drawing.

April and May. If it is delayed till July the injury caused is slight. Optimum conditions for infection are provided in warm weather with intermittent rain and sunshine. In 1932 such conditions did not occur until exceptionally late. The very mild early months of the preceding winter were followed by cold wintry weather from February until the end of May. May, the most important month for cane-infection, was consistently cold and dull with almost continuous rain (3.06 ins. in 24 days). In complete contrast June was a dry sunny month of average temperature; rain fell on five days, the only considerable fall taking place on June 30th (0.58 ins.). It was not until late July that conditions favourable for infection occurred. The early part of this month was dry but the latter half, particularly the last week, was showery.

It will be seen from the above data that in this season suitable conditions for severe cane-spot infection did not occur until towards the end of July. That the main wave of infection did take place at this time is confirmed by the scarcity of "pit-lesions" on the new canes and laterals and by the serious infection of the later maturing fruits in the manner described above. It is interesting to note that in the Scottish districts (where picking commences approximately one month later than in England) it was reported that the earliest pickings of fruit were more seriously affected than the later pickings.

4. CONTROL.

Hitherto it has been assumed that a severe reduction of the crop of susceptible varieties by the cane-spot disease is mainly due to injury caused by a severe infection of the new canes of the previous year in the early stages of their growth (i.e. in April and May). Consequently spraying in any one year has been carried out for the sake of the crop of the following year. As a result of the experience of 1932 it is clear that under certain seasonal conditions the brunt of the infection is borne directly by the fruits themselves and considerable injury caused to the *current year's crop*. This second type of injury provides an additional reason for the regular annual spraying of susceptible varieties. As the efficacy of the spray depends on its direct action on the fungal fructifications on the fruiting canes, there is every reason to believe that an adequate control of direct fruit injury will be obtained by applying the spray at the "delayed-dormant" and "pre-blossom" stages previously recommended (3). That the action of sprays thus applied persists long enough to prevent fruit infection is suggested by the fact, previously determined, that the "superficial" type of lesion, normally appearing on the current year's canes in late August, is considerably controlled by this treatment. (See 3, p. 90, Table VII.)

SUMMARY.

1. A deformation of the fruits of certain varieties of raspberry occurred in wide-spread districts in 1932 and was found to be due to their infection in an immature condition with the cane-spot fungus (*Plectodiscella veneta*).

2. The symptoms of this phase of cane-spot attack are described in detail and its occurrence is correlated with the exceptional weather conditions in the early part of the 1932 season.

3. The efficacy of the previously formulated spraying schedule in controlling this form of injury is discussed.

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SOME INCIDENTAL EFFECTS OF ROUTINE SCAB- SPRAYS, WITH SPECIAL REFERENCE TO APPLE FRUIT SAWFLY-CONTROL—A SIDELIGHT ON THE INTERPRETATION OF FIELD SPRAYING EXPERIMENTS

BY M. H. MOORE

IN the course of certain spraying experiments in the control of Apple Scab carried out by the writer during the past few years, a wide range of necessary data was obtained. Close analysis of these data showed that certain sprays yielded incidental advantages not anticipated when the experiments were designed. It was found, in fact, that Bordeaux mixture and lime-sulphur, each with or without lead-arsenate, were not only of great value in controlling Apple Scab, but they also showed distinct tendencies to reduce damage caused by other agencies, notably Apple Fruit Sawfly (*Hoplocampa testudinea*) and the Brown Rot fungus (*Sclerotinia fructigena*). Reference has already been made to these results in a recent paper (8), where the figures for Brown Rot-infection were tabulated and discussed.

In the present paper, it is proposed to present and discuss the available data concerning the control of Apple Fruit Sawfly, and to touch on such of these incidental advantages as may be of commercial interest. It should be clearly understood at the outset, however, that modifications of existing routine methods for Apple Fruit Sawfly-control are not visualized, for the presentation of these results is intended to show only that spray-applications for Scab-control can provide assistance of a supplementary nature.

I. APPLE FRUIT SAWFLY-CONTROL.

Reference must be made elsewhere (5) for a full account of the scope and the lay-out of the Scab-control spraying experiments. It was not until 1930 that many data on the fruit were forthcoming, for the trees, being young, had not reached full bearing. In that year, however, there was a large crop, and, from petal-fall onwards, all dropped fruitlets were picked up, counted and graded for Scab and Sawfly. From such records as these, it was possible to ascertain to what extent fruit-drop could be attributed to Scab and to Sawfly, and how much, if any, to spray-damage.

Thus, the data on Sawfly-attack were primarily used as a means to an end, but when they were classified, they showed an unexpected result.

RESULTS IN 1930.

The figures are arranged in Table I.

TABLE I.

PERCENTAGE OF SAWFLY-INFESTED FRUITS IN THE WHOLE CROP, DROPPED AND PICKED (1930).

Variety: Cox's Orange Pippin.

Rootstock.	Number and Time of Spray Applications.	Av. total crop† produced per tree.			% Sawfly-infested.		
		BMA.	LSA.	A.	BMA.	LSA.	A.
No. I.	} One pre-blossom ("pink-bud") ..	125	397	213	12	16	36
" II.		249	387	371	18	15	28
" IX.		155	193	235	13	9	25
" XVI.		123	177	97	6	7	24
" V.	} Two post-blossom	148	449	299	12	32	33
" XIII.		168	308	302	12	19	32
" III.	} One pre- and two post-blossom ..	103	440	371	6	14	29
" IV.*		126	374	229	17	11	34
		LSG.	CSG.	G.	LSG.	CSG.	G.
		137	147	145	25	25	21
" VI.	} Two post-blossom	249	169	158	29	25	20
" X.							

* No lead-arsenate on trees on No. IV. stock.

† Total crop (dropped and picked together) expressed as number of fruits.

Explanation of Table I.

Bordeaux mixture (BM.) was used at 8-8-100 (burnt lime) at the "pink-bud" stage and at 8-25-100 ("excess" burnt lime) post-blossom, lime-sulphur (LS.) at 1-30 pre-blossom and 1-100 post-blossom (except on trees on stocks Nos. VI and X, where the dilution was 1-150) and colloidal sulphur (CS.), applied post-blossom only, at 4 lbs. per 100 gallons. Lead-arsenate paste (A.), at 4 lbs. per 100 gallons was used throughout on all trees (except those on stocks Nos. IV, VI and X) to control caterpillar-attacks. "Spray"-gelatine (G.), at 1 lb. per 100 gallons was used as "spreader" on all trees on Nos. VI and X stocks.

Post-blossom sprays were applied first at petal-fall and again three weeks later.

Generally, there were sixteen trees on each rootstock, of which six were controls and, of the remainder, five were sprayed with one fungicide and five with the other. An exception to this rule was shown by stock No. IV, on which there were eight trees only.

DISCUSSION OF RESULTS.

In 1923, Grubb and Bagenal (1) showed that an application of lead-arsenate (in combination with lime-sulphur) at 4 lbs. per 100 gallons, "immediately after the blossom fell," greatly reduced the number of fruits attacked by Apple Sawfly larvae in that year, where a similar application "several days before the first blossoms opened" was not effective. They remark that "one can hardly escape the conclusion that the young larvae, before penetrating the fruits, consumed enough arsenate to kill them."

The use of lead-arsenate in this way, that is, as a stomach poison, was regarded as a routine measure (albeit not always satisfactory) for Sawfly-control until Petherbridge and Tunnington, in February, 1929, published a paper (9) containing results

of experiments with nicotine and soft soap applied from "a nozzle giving a coarse spray", that is, applied as a contact insecticide. Petherbridge, in 1926, had used lead-arsenate *alone* at the rate of 6 lbs. per 100 gallons of water on Worcester Pearmain (a variety particularly susceptible to attack by this pest) "before the last petals had dropped", and the results were most unsatisfactory. In 1927, very promising results were obtained on the same trees by spraying with nicotine and soft soap "immediately following the drop of the petals". These good results were confirmed in the following year when the spray was applied "seven days after the last petals had fallen". (A second application made seven days after this, further reduced the percentage of Sawfly-damaged apples.)

The nicotine and soft soap treatment has thus tended to become more relied upon as a routine measure* than the arsenate treatment, although Petherbridge (9) recommends that, "in view of the results obtained by Grubb and Bagenal, lead-arsenate should be added to fungicide sprays, such as lime-sulphur and Bordeaux mixtures, when these are applied soon after the fall of the petals."

It is clear, therefore, that the greatest stress has been placed by these writers on the time of application of sprays, the most favoured period being soon after petal-fall. Petherbridge (9) points out that "from what is known of the life-history of this Sawfly, it is probable that the time of application of the wash will be an important factor in its control."

Turning again to the present results, Table I shows that, in 1930, a *pre-blossom application only* of Bordeaux mixture with arsenate or of lime-sulphur with arsenate reduced the percentage of Sawfly-infested fruits to less than one-half (taking the average of the twenty trees on the four rootstocks Nos. I, II, IX and XVI) of that on trees sprayed with lead-arsenate only. In other words, although it is remotely possible that some control of this pest was given by lead-arsenate, applied pre-blossom, alone, yet *there was a further reduction in Sawfly-infestation of more than 50 per cent where lead-arsenate was used in combination with either fungicide*. Bordeaux mixture was slightly more beneficial in this respect than lime-sulphur on trees on No. I stock, and less beneficial on those on No. II and No. IX, but these differences are very slight and are probably not significant. The attractiveness of the petals was not visibly impaired by the application of any of these sprays.

A similar result was shown where post-blossom applications only of Bordeaux mixture with arsenate were applied, although, presumably, only the first post-blossom spray was responsible, for the second (three weeks after petal-fall) probably would be applied too late to have much effect. Weak lime-sulphur (1-100) with arsenate was not similarly beneficial on trees on No. V stock, and was less effective than Bordeaux mixture with arsenate on those on No. XIII. Reduction in the strength of lime-sulphur for post-blossom application appears to be accompanied by reduction of efficiency against this Sawfly as well as against Scab (8). This was also shown by the data published by Grubb and Bagenal (1).

Trees on stock No. III received three applications of spray, one pre- and two post-blossom. Bordeaux mixture with arsenate reduced infestation to one-fifth, while lime-sulphur with arsenate reduced it to one-half of that shown by trees sprayed with arsenate alone.

SPRAYS WITHOUT LEAD-ARSENATE.

Trees on stock No. IV received the same spray treatment as those on No. III except that lead-arsenate was omitted, and the experiment thus compared the relative

* No routine treatment specially for Sawfly-control has been given to trees in the present experiments.

merits merely of Bordeaux mixture and lime-sulphur as fungicides. Control trees were unsprayed, and showed an average of 34 per cent Sawfly-infested fruits. Bordeaux mixture, applied three times, gave 17 per cent fruits infested (exactly one-half) while lime-sulphur gave 11 per cent infested (one third). As the number of trees in this instance was small, it would, perhaps, be unwise to claim from this result that lime-sulphur alone was significantly more efficient than Bordeaux mixture alone. Trees on this stock (No. IV) cropped heavily, however, and this justifies the obvious inference that *both Bordeaux mixture and lime-sulphur, each without lead-arsenate, gave some control of Apple Fruit Sawfly in 1930 when applied pre- and post-blossom.** It is not possible to be certain whether this was due to the pre-blossom application, or to the first post-blossom, or to both. It has already been suggested, however, that the efficacy of lime-sulphur is reduced when the strength of the spray is decreased, which would indicate that some, at least, of this control must be attributed to the pre-blossom application.

Trees on Nos. VI and X stocks were sprayed, post-blossom only, with lime-sulphur (1:150) or with colloidal sulphur (0.4 per cent), each with gelatine but without arsenate. The controls were sprayed with gelatine solution only. Neither of these weak sulphur sprays showed any control of Sawfly.

The Effect of Lead-Arsenate.

Comparison between arsenate-sprayed controls on the one hand and gelatine-sprayed and unsprayed controls on the other, suggests that little, if any, effect on this Sawfly was shown by lead-arsenate alone.

It is possible that the *apparent* effect of lead-arsenate in Grubb and Bagenal's experiments (1) was due to their using *a combination of lime-sulphur with arsenate*. These writers were comparing the effects of a fungicide with those of that fungicide with arsenate. There were no trees sprayed with only lead-arsenate suspension.

Miles (4), noting that Grubb and Bagenal obtained control of Sawfly by post-blossom lead-arsenate applications while Petherbridge and Tunnington did not, suggests a possible explanation for lack of control in the latter instance. Although such an explanation may be valid, it would not appear to be permissible, in view of the present results, to assume that Petherbridge and Tunnington's data (from trees sprayed with arsenate alone) were necessarily in contrast with those of Grubb and Bagenal, for the sprays respectively used were not strictly comparable.

Thus, apart from the practical advantage of the ability of certain fungicides to act as insecticides, it is desirable to emphasize also the theoretical aspect of the present findings in their bearing on the interpretation of results of spraying experiments. For example, in any scheme of insecticidal spraying, allowance must be made for the possible insecticidal effect of an accredited fungicide, if such be present. Conversely, in spraying against fungous parasites, the possible fungicidal effect of any insecticide present must be taken into consideration.

It has already been shown that control of Apple Fruit Sawfly in 1930 was afforded only by lead-arsenate with a fungicide or by the fungicide alone, and not by lead-arsenate alone. It is not easy to provide an explanation of this. The pre-blossom application, just before flowering, of Bordeaux mixture or of lime-sulphur, each with or without lead-arsenate, might act as a deterrent to the adult Sawfly, causing it to lay its eggs elsewhere than on sprayed trees. In Grubb and Bagenal's experiments (1), which were primarily designed to obtain data on the control of Apple Scab, both lime-sulphur and

* Parrott, P. J. ("A Summary of Important Insects and Spray Developments." *Proc. 72nd Ann. Meeting, New York State Hort. Soc., Rochester, N.Y.* (1927) 4-13) mentions the insecticidal properties of Bordeaux mixture in connection with the control of the young nymphal stages of Leafhoppers attacking apples in U.S.A.

Bordeaux mixture were used with and without lead-arsenate. Apart from the control of Sawfly (noted above) by lead-arsenate in combination with a fungicide, however, these authors considered that the fungicides alone "may have slightly reduced the Sawfly attack". They further suggested that "it is at least conceivable that where a few trees in a large plantation are sprayed with these mixtures, the adult Sawflies might prefer other trees for egg-laying." That explanation, however, is untenable when applied to their results, for those to which reference is made concerned *post-blossom* spray-applications (the first of which was made "immediately after the blossom fell" when, presumably, egg-laying had ceased!) on trees not sprayed pre-blossom.

Another explanation must be sought where control was given by only post-blossom applications, as also shown by the present experiments. An assumption of the direct, poisoning action of the combined spray (and, indeed, of the fungicide alone) on the larvae, or of some undetermined action on the egg, would appear to be as feasible as any, but it must remain for further entomological work to shed some light on this problem.

As the present results already discussed concern only the 1930 season, it will be advantageous to look for confirmation of them among data collected in subsequent years' investigations.

RESULTS IN 1931 AND 1932.

The experiments in Scab-control (5, 8) to which reference was made at the beginning were re-planned for the 1931 season, and advantage was taken of the opportunity to apply tests based on the previous four years' results. Thus, all trees were sprayed at least pre-blossom, and sulphur dusting as a means of Scab-control was compared with wet spraying. For further details concerning the lay-out and general procedure adopted in these re-planned experiments, reference must be made to pages 64 *et seq.* of a previous paper (6). As in 1930, the data on Sawfly-control, presented in the following Table II, were obtained incidentally to those on fruit-drop.

Explanation of Table II.

- LS. Lime-sulphur ; 1-30 pre-blossom, 1-100 post-blossom.
- BM. Bordeaux mixture ; 4 lbs. Copper Sulphate and 18 lbs. hydrated lime per 100 gallons, pre- and post-blossom.
- CS. Colloidal sulphur ; 8 lbs. per 100 gallons pre-blossom, 4 lbs. per 100 gallons post-blossom.
- A. Lead-arsenate paste ; 4 lbs. per 100 gallons, pre- and post-blossom.
- G. "Spray"-gelatine ; 1 lb. per 100 gallons, pre- and post-blossom.
- S'. Sulphur dust.
- A'. Lead-arsenate dust.
- S'A'. Sulphur-with-arsenate dust.
- No spray or dust treatment.

Pre-blossom applications were made at the "pink-bud" stage (see (7), Fig. I), and, on trees on stocks Nos. V and XIII, where two pre-blossom sprays were given, the first was applied at the "green-bud" stage (see (7), Fig. III). No post-blossom treatment was given to trees on stock No. XIII, while those on other stocks received an application at petal-fall (see (7), Fig. IV), and another three weeks later. Trees on stock No. VI received four post-blossom dust-applications at intervals of ten days.

TABLE II.

PERCENTAGE OF SAWFLY-INFESTED FRUITS IN WHOLE CROP, DROPPED AND PICKED
(1931 AND 1932).

Variety: Cox's Orange Pippin.

Rootstock.	Spray Treatment.		No. Trees.	1931.		1932.	
	Pre- blossom.	Post-blossom.		Total crop.*	% Sawfly- infested.	Total crop.*	% Sawfly- infested.
No. I.	LSA.	LSA, LS.	8	433	24	2,390	1.3
	A.	A, —	8	194	49	1,059	1.6
„ II.	LSA.	S'A', S'.	8	382	35	4,392	0.6
	A.	A', —	8	346	51	1,802	1.9
„ III.	CSA.	CSA, CS.	8	430	48	1,647	1.0
	A.	A, —	8	248	50	1,371	1.8
„ IV.	BMA.	BMA, BM.	4	459	21	2,149	3.5
	A.	A, —	4	888	46	2,097	2.2
„ V.	LSA, LSA.	S'A', S'.	8	529	35	3,965	1.1
	A, A.	A', —	8	240	51	1,971	2.2
„ VI.	S'A'.	S'A', S', S', S'.	8	308	27	1,157	0.5
	A'.	A', —, —, —	7	237	48	1,026	1.1
„ IX.	LSA.	CSA, CS.	8	1,290	52	2,642	1.3
	A.	A, —	8	909	67	1,853	2.2
„ X.	S'A'.	S'A', S'.	8	344	26	1,346	2.0
	A'.	A', —	7	123	38	612	1.8
„ XIII.	LSA, LSA.		8	212	40	1,870	3.3
	A, A.		8	77	24	938	2.8
„ XV.	BMA.	BMA, BM.	4	29	14	470	0.6
	A.	A, —	4	30	17	580	3.1
„ XVI.	LSAG.	LSAG, LSG.	8	114	23	1,383	0.7
	AG.	AG, G.	8	76	18	1,663	1.3

* Total crop (dropped and picked together) expressed as number of fruits.

DISCUSSION OF RESULTS.

1931. Of the eleven different experiments—to which convenient reference can be made by numbering them similarly to the rootstocks—only two indicate a greater percentage of Sawfly-infested fruits from fungicidally-treated trees than from arsenate-sprayed (or dusted) controls. These two exceptions are provided by experiment No. XIII (no post-blossom treatment) and experiment No. XVI (same treatment as in experiment No. I with the addition of “spray”-gelatine). The experience of 1930, when a “pink-bud” application of lime-sulphur with lead-arsenate gave much greater control of Apple Fruit Sawfly than lead-arsenate alone, was, therefore, not confirmed by experiment No. XIII in 1931. There are two possible explanations of this: (1) that control by a “pink-bud” application is likely to occur only in certain seasons (for it is not known in what manner the spray might act as a deterrent to the adult, or what,

if any, difference results from slight variation in the period of application in relation to the development of the blossom-trusses), and (2) the very light crop borne by the controls compared with the sprayed trees in experiment No. XIII. The crop was not hand-thinned on any of the trees, and crowded clusters of fruit were allowed to develop naturally. It is not unreasonable to expect that more fruits would be attacked by the Sawfly larvae where several fruits are in close contact than where they are thinly dispersed over the tree. Massee's recent observations (3) on the habits of the larvae of this pest give support to this explanation. The amount of blossom borne by control and by sprayed trees in this experiment (No. XIII) was very similar.

Apart from this exception, however, it can be claimed that the results in 1931 confirm those of 1930 in that *much better control of this Sawfly was obtained by the use of arsenate with a fungicide than by arsenate alone*. There were no experiments in these re-arranged trials to show results from a fungicide acting independently of lead-arsenate. Colloidal sulphur, as in 1930, was not effective, even with arsenate, but sulphur-with-arsenate dust was nearly as effective as the lime-sulphur-with-arsenate spray. The result from experiment No. XV is unreliable owing to the extremely small crop.

Comparison between experiments No. III and No. IX would appear to indicate that here, though not with experiment No. XIII, there *was* some slight effect of the "pink-bud" application, lime-sulphur with arsenate proving somewhat effective where colloidal sulphur with arsenate was not (the post-blossom treatment was the same in each case). It is not possible to show by these data whether the type of rootstock can affect the result in any way, although, in this connection, it is interesting to recall that trees on No. IX stock usually blossom a day or so in advance of the others.

Bordeaux mixture with arsenate (experiment No. IV) was as effective as lime-sulphur with arsenate (experiment No. I). Comparison between experiments No. I and No. XVI indicate that the inclusion of gelatine, in the latter instance, had some influence in preventing the beneficial action of the combined spray against this Sawfly. The crop on trees on No. XVI stock, however, was light, and this result thus loses much of its significance.

1932. The figures clearly show that Sawfly-damage was virtually non-existent on these trees in 1932, although the crop (both dropped and picked) was very heavy. This might be a seasonal effect, but it is most unlikely, for Sawfly-damage was prevalent elsewhere. As Capsid-damage had been increasing on the plot during the previous few years, *all* the trees received, in bright, sunny weather, a *pre-blossom* application of nicotine (8 ozs. per 100 gallons) with soft soap (8 lbs. per 100 gallons) in 1932 for the first time. Owing to the rapid development of the blossoms in that year, the spray was applied after some of them had opened. Spray-damage resulted,* for many of the petals of closed, as well as of expanded flowers, had turned brown and withered by next day.

Although it normally is not advised to apply nicotine and soft soap *pre-blossom* for *Apple Fruit Sawfly-control*, it is considered that this particular routine application must accidentally have provided exceptional control on these trees. Application of the spray, being delayed, may have coincided with the beginning of adult Sawfly activity and acted as a deterrent, especially as the attractiveness of many of the petals had been impaired by the spray. Support for this view is provided by general observation of two other, adjacent, plots of trees on the Research Station, one of which received nicotine and soft soap (for Capsid-control) immediately pre-blossom, on the same day (17th May) as the Cox's, while the other had no similar treatment. Fruits on the sprayed plot

* It is not suggested that this damage was entirely due to "lateness" of application.

showed little Sawfly-damage, while those of the same variety (Lane's Prince Albert) on the unsprayed plot showed appreciable Sawfly-damage.*

Little can be gained from closer examination of the 1932 results in Table II apart from the fact that, even with so little Sawfly-infestation, there was a general tendency for this to be rather less on trees sprayed or dusted with arsenate combined with fungicide than with arsenate alone.

2. BROWN ROT-CONTROL.

Another incidental advantage of routine spraying against Apple Scab is the indirect control afforded of Brown Rot of the fruits. Data obtained on these Cox's Orange Pippin trees in one year, 1930, showed that infection was always greater on control trees than on those sprayed with lime-sulphur with or without lead-arsenate. Brown Rot infections were found to occur at points where the fruits had been cracked by Scab-infection or bitten by Sawfly larvae and other caterpillars. On trees sprayed with Bordeaux mixture, another factor was introduced. A "*pink-bud*" application caused severe fruit *cracking* and russetting. Brown Rot obtained entry through the cracks, and thus, in some instances, there was even greater infection on Bordeaux-sprayed trees than on corresponding controls. *Post-blossom* Bordeaux applications caused surface russetting but very little cracking, and, on these fruits, Brown Rot-infection was rarely found.

3. RED SPIDER AND APPLE MILDEW-CONTROL.

Trees sprayed or dusted with sulphur showed much greater freedom from the Fruit-Tree Red Spider (2) (by inspection) and from Apple Mildew (by classified data) than either controls or Bordeaux-sprayed trees. On many control trees, the damage caused by Red Spider was serious, for the leaves were yellow and sickly by midsummer, and the fruits were much reduced in size.

4. CATERPILLAR-CONTROL.

Lead-arsenate can be incorporated with a fungicidal spray, such as Bordeaux mixture, lime-sulphur or colloidal sulphur, thus obviating the necessity for a separate application for the control of various leaf-eating caterpillars (for example, those of Winter Moth). An added advantage of the combined spray over the fungicide alone is its enhanced efficacy against Apple Scab (8).

SUMMARY.

Routine fungicidal applications designed to control Apple Scab were advantageous also in the control of Apple Fruit Sawfly and Brown Rot of the fruits, Fruit-Tree Red Spider and Apple Mildew (these two when sulphur was the fungicide used), and, where lead-arsenate was included, of various leaf-eating caterpillars.

With regard to Apple Fruit Sawfly, it is indicated by results in 1930 that a "*pink-bud*" application only, of either Bordeaux mixture (8-8-100) or lime-sulphur (1-30), each with lead-arsenate (0.4 per cent), gave equal control, probably by acting as a deterrent to the adult, while post-blossom applications (the "*active*" one being, presumably, that made at petal-fall), without a pre-blossom, also gave control, Bordeaux mixture (8-25-100) with arsenate (0.4 per cent) being more effective than lime-sulphur (1-100) with arsenate (0.4 per cent). Decrease in the strength of lime-sulphur when

* The writer is indebted to Mr. J. Amos for this information.

applied post-blossom resulted in decrease in efficiency against Sawfly. Pre- and post-blossom applications (together) of either fungicide, *with or without lead-arsenate*, reduced Sawfly-infestation to at least one-half of that found on control trees. Both lime-sulphur (1-150) and colloidal sulphur (0.4 per cent), each with "spray"-gelatine (0.1 per cent), gave no control when applied post-blossom only. There was evidence that lead-arsenate alone gave little, if any, control.

Confirmation of the main results was shown in 1931, when sulphur-with-arsenate dusting also proved effective, but regarding 1932, a "delayed pink-bud" routine application of nicotine and soft soap (for Capsid-control) is suggested as being the cause of virtual lack of Sawfly-infestation on *all* trees, in spite of a heavy fruit crop.

No suggestion is entertained that the results of these observations preclude the necessity for making routine spray-applications of nicotine and soft soap as at present recommended by investigators of Apple Fruit Sawfly-control. (In fact, the figures presented—not in this case the results of an experiment in Sawfly-control—suggest that the best control of all, though accidental in the circumstances, was seen when nicotine and soft soap were used.) They are presented to show how spraying against Apple Scab can give practical aid of an accessory nature, and to emphasize their bearing on the interpretation of the results of field spraying experiments.

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SPRAYING TRIALS AGAINST PEAR SCAB (*VENTURIA PIRINA*)

SOME PRACTICAL AND THEORETICAL ASPECTS OF THE INTERPRETATION OF THE RESULTS

By M. H. MOORE

FIELD spraying trials were undertaken at East Malling in 1931 and 1932 on Fertility pears to obtain comparisons of the efficacy of certain sprays for Scab-control. The immediate practical application of the results will be presented elsewhere. Further analysis of the figures, however, revealed certain points of a more fundamental nature, and it is proposed to deal with these aspects in the present paper.

Eighty nine-year-old Fertility trees, twenty on each of four rootstocks, Quince A, B, C and D respectively, were sprayed once pre-blossom (at "white-bud") and twice post-blossom (at petal-fall and again—except controls—three weeks later) from a barrel-machine operated by hand and working at a pressure of 200-220 lbs. per square inch. Manipulation was hindered by close planting and intercropping, so that satisfactory "cover" was difficult to achieve.

Of each twenty trees on Quince A, B and C respectively, five were controls, five received burnt-lime Bordeaux mixture, five lime-sulphur and five colloidal sulphur. Of the twenty on Quince D, ten were controls and ten received hydrated-lime Bordeaux. Lead-arsenate only was used on controls, and it was added to all the fungicides at "white-bud" and petal-fall. Fungicides only were used for the second post-blossom application, the controls being unsprayed.

A plan of the general arrangement is given overleaf.

Each symbol represents one pear tree sprayed as under. The pear trees stood at 15 feet apart; between each two was a plum tree, and between the rows (which were 15 feet apart) were black currants. A roadway formed a boundary for the plot on the north and east sides. To the south and west the plantation was continued.

STRENGTHS OF SPRAYS.

1931.

- = Home-made burnt-lime Bordeaux (8-8-100) with arsenate (0.4%), pre- and post-blossom.
- = Home-made hydrated-lime Bordeaux (8-12-100) with arsenate (0.4%), pre- and post-blossom.
- ▣ = Lime-sulphur (1-30 pre-blossom, 1-60 post-blossom) with arsenate (0.4%), pre- and post-blossom.
- = Colloidal sulphur (0.8% pre-blossom, 0.4% post-blossom) with arsenate (0.4%), pre- and post-blossom.
- + = Lead-arsenate (0.4%), pre- and post-blossom.

No "spreader" was used. For the second post-blossom application, burnt-lime Bordeaux* was used at 8-25-100 and lime-sulphur at 1-100 on account of damage caused by these sprays when used at petal-fall.

* Damage by Bordeaux in 1931 was due to known causes easily avoided in 1932.

PLAN OF TRIALS.

				Quince D.	C.	B.	A.
Pears, plums and black currants.				+	—*	+	○
				●	■	■	■
				+	■	■	■
				+	+	○	+
				●	○	+	○
				+	■	■	■
				●	■	■	■
				+	+	○	+
				+	○	+	○
				●	■	■	■
■	■	■	●	Pears, plums and black currants.			
+	○	+	■				
○	+	○	+				
■	■	■	+				
■	■	■	●				
+	○	+	+				
○	+	○	+				
■	■	■	●				
■	■	■	—*				
+	○	+	●				
Quince A.	B.	C.	D.				

* Tree missing.

1932. As in 1931 with the following exceptions: Lime-sulphur (1-30) instead of colloidal sulphur (0.8%) pre-blossom, both post-blossom burnt-lime Bordeaux at 8-8-100, and both post-blossom lime-sulphur sprays at 1-100.

TIMES OF APPLICATION.

1931. "White-bud" on 22nd April, petal-fall on 15th, 16th and 18th May, and three weeks later on 5th June.

1932. "White-bud" on 29th April, petal-fall on 23rd and 24th May, and three weeks later on 13th June.

METHODS USED FOR OBTAINING RESULTS.

The fruits were thinned to "singles" on 30th June in 1931 and on 12th July in 1932. Both thinnings and fruits picked at maturity ("picking maturity") were Scab-graded by the "category" method (already described for apples (1)), by which

the fruits were classified into five grades, one comprised of entirely unscabbed fruits and the other four, respectively, of fruits showing Scab-infection to various degrees of severity, ranging from lightly-scabbed to heavily-scabbed. By allotting to each "category" a numerical equivalent, the approximate area of Scab, assessed by inspection, was shown for each series of similarly-sprayed trees as a number, referred to as the "Scab-Equivalent". By comparing this "Equivalent" with that of the controls, it was possible to express the Relative Efficiency of the fungicides for Scab-control in numerical form, which enabled the respective merits of the sprays to be appraised at a glance.

Similarly, the number of fruits scabbed (irrespective of the collective area of the Scab-spots) was expressed as a percentage, for each series of similarly-sprayed trees, of the total number of fruits examined,* and the Relative Efficiency of the spray was determined as before.

An example of the method of calculation used for expressing the Relative Efficiencies of the sprays based on (a) percentage of scabbed fruits, (b) total area of Scab-infection, is given below.

Counting Method.

(i) Unsprayed tree. 100 fruits, 50 scabbed. % Scab=50.
 (ii) Sprayed tree. 100 fruits, 10 scabbed % Scab=10.
 On 50% there was a reduction of 40%. Therefore the efficiency of the spray was $\frac{40 \times 100}{50}$
 $= 80\%$
 Efficiency I=80.

Grading Method.

(i) Unsprayed tree :
 Categories

	0	0— $\frac{1}{4}$	$\frac{1}{4}$ — $\frac{1}{2}$	$\frac{1}{2}$ —1	1—2
No. of Fruits	50	10	12	15	13
No. fruits $\times$ Category mean =	0	$\frac{10}{8}$	$\frac{36}{8}$	$\frac{90}{8}$	$\frac{156}{8}$
Sum of Products =			$\frac{292}{8}$		
Scab-Equivalent =			$\frac{\text{Sum of Products} \times \text{Constant}^\dagger}{\text{No. of Fruits}}$		
			$= \frac{292}{8} \times \frac{100}{100}$		
			$= 36.5$		

(ii) Sprayed tree :
 Categories

	0	0— $\frac{1}{4}$	$\frac{1}{4}$ — $\frac{1}{2}$	$\frac{1}{2}$ —1	1—2
No. of Fruits	90	10	0	0	0
No. fruits $\times$ Category mean =	0	$\frac{10}{8}$	0	0	0
Sum of Products =		$\frac{10}{8}$			
Scab-Equivalent =		$\frac{10}{8} \times \frac{100}{100}$			
		$= 1.25$			

On 36.5 there was a reduction of 35.25. Therefore the efficiency of the spray was $\frac{35.25 \times 100}{36.5}$
 $= 97\%$
 Efficiency II=97.

* Where the crop on a tree was heavy, a representative random sample of the fruits was Scab-graded. Time would not permit of the whole crop being graded by one person, and the sampling method was thus adopted as a means of preserving a uniform grading standard.

† Introduced to avoid decimals.

It is considered that the grading method gives the more accurate result, but comparison between the results obtained on the same fruits by the two methods of expression provided a valuable clue as to the commercial values of the respective fungicides. For example, the efficiencies of two different fungicides may be similar when results are based on the approximate total area of Scab-spots. Yet in one case the area may be made up of numerous relatively small infection-spots "spread over" many fruits, while in the other it may consist of larger infection-spots on few fruits. Hence, although either fungicide is as effective as the other when area of infection is considered, yet, other things being equal, the sample containing fewer scabbed fruits will be the more commercially valuable.

In the present worked example, the difference between Efficiency I (80) and Efficiency II (97), on the same fruits, indicates at once that the total Scab-area was small, but was "spread over" a relatively high proportion of fruits. Although this example is synthetic, it is by no means exaggerated.

RESULTS.

The figures* are arranged in tabular form below. The results for each year, 1931 and 1932, on thinned fruits and on those picked at maturity, are shown separately, together with the average of the two. The lower the Efficiency figure, of course, the greater the Scab-infection.

DISCUSSION OF RESULTS.†

1931. The figures support the general impression, formed soon after the experiments were begun, that the colloidal sulphur‡ was not satisfactory in controlling Scab on Fertility. This spray caused no damage, either. It will be seen that, even by 30th June when the fruits were thinned, Scab-infection was already severe on trees sprayed with colloidal sulphur. Thinning, itself, results in the removal (by design) of many of the early infections, so that the picked fruits, on the whole, were not so severely affected as the thinned fruits. Although the proportion of *picked* fruits, scabbed, was high, the area of fruit covered by Scab was not large in proportion, for the infection-spots, being mainly of late occurrence, were *relatively* small. Hence Efficiency I was low (28) while Efficiency II was relatively high (50).

Much better control was shown by lime-sulphur than by colloidal sulphur but, here again, the proportion of *picked* fruits, scabbed, was high (Eff. I, 68) relative to the total area of the infection-spots (Eff. II, 85). Evidently the reduction in strength of lime-sulphur for post-blossom application rendered this spray the less able to check "secondary" Scab-infection. Extensive leaf-burn, however, resulted from the petal-fall application at 1-60.

Burnt-lime Bordeaux mixture showed control similar to that shown by lime-sulphur where the results were based on Scab-areas, but, in this case, the proportion of *picked* fruits, scabbed, was low (Eff. I, 90) relative to the total area scabbed (Eff. II, 88). In other words, although burnt-lime Bordeaux gave similar control of Pear Scab, it was more commercially valuable in this respect than lime-sulphur because it kept a greater proportion of fruits clean. Each spray, however, gave good "commercial" control.

* These have been subject to statistical analysis, and the major claims put forward in the discussion of results were shown to be valid.

† Fruits removed at thinning are referred to as "thinned fruits", while those gathered at picking maturity are termed "picked fruits".

‡ Possibly the "performance" of this spray would be improved by using it with a "spreader", such as soft soap.

TABLE I.

PEAR SCAB SPRAYING TRIAL, 1931.

Variety—Fertility.

Rootstock.	Lead-Arsenate ("Controls").				Colloidal Sulphur + Lead-Arsenate.				Lime-Sulphur + Lead-Arsenate.				Bordeaux Mixture + Lead-Arsenate.			
	No. Trees.	Total No. Fruits.	% Scabbed.	Scab-Equiv.	No. Trees.	Total No. Fruits.	Eff. I.	Eff. II.	No. Trees.	Total No. Fruits.	Eff. I.	Eff. II.	No. Trees.	Total No. Fruits.	Eff. I.	Eff. II.
Quince A.	5	390	35	10.7	5	530	11.4	—	THINNED FRUITS.				5	152	97.1	98.1
" B.	5	365	51	19.4	5	408	47.1	59.8					5	106	72.5	56.2
" C.	5	306	59	32.9	5	331	45.8	50.2					4	88	81.4	81.8
" D.	10	926	40	17.9	—	—	—	—					9	935	70.0	54.2
Average*	A,B,C. D.	71 93				85	35	26		76	84	81		25 104	84 70	79 54
Quince A.	5	265	89	25.9	5	310	29.2	29.0	FRUITS PICKED AT MATURITY.				5	206	94.4	93.4
" B.	5	337	87	30.8	5	300	19.5	52.6					5	89	80.5	77.3
" C.	5	126	93	45.5	5	353	34.4	67.7					4	94	94.6	93.8
" D.	10	552	89	34.2	—	—	—	—					9	678	85.4	80.1
Average*	A,B,C. D.	49 55				64	28	50		59	68	85		28 75	90 85	88 80
Quince A.	5	655	62	18.3	5	840	20	0	SUMMARY FOR THINNED AND MATURE FRUITS TOGETHER.							
" B.	5	702	69	25.1	5	768	33	56								
" C.	5	432	76	39.2	5	684	40	59								
" D.	10	1,478	65	26.1	—	—	—	—								
Average*	A,B,C. D.	119 148				149	31	38		135	76	83		53 179	87 78	84 67

NOTE. For details concerning sprays, see text.

* Crop averages given in number of fruits per tree.

TABLE II.
PEAR SCAB SPRAYING TRIAL, 1932.
Variety—Fertility.

Rootstock.	Lead-Arsenate ("Controls").				Lime-Sulphur + Lead-Arsenate pre-blossom. Colloidal Sulphur + Lead-Arsenate post-blossom.				Lime-Sulphur + Lead-Arsenate.				Bordeaux-Mixture + Lead-Arsenate.			
	No. Trees.	Total No. Fruits.	% Scabbed.	Scab- Equiv.	No. Trees.	Total No. Fruits.	Eff. I.	Eff. II.	No. Trees.	Total No. Fruits.	Eff. I.	Eff. II.	No. Trees.	Total No. Fruits.	Eff. I.	Eff. II.
Quince A.	5	1,467	58	30.2	5	1,669	27.6	59.3	5	1,396	70.7	80.5	5	486	65.5	68.5
" B.	5	920	62	25.5	5	738	56.5	69.0	5	1,191	61.3	81.2	5	512	58.1	58.8
" C.	5	940	83	48.8	5	471	31.3	45.9	5	395	51.8	70.1	4	88	78.3	87.9
" D.	10	1,676	69	30.2	—	—	—	—	—	—	—	—	9	1,714	72.5	85.4
Average*	A,B,C. D.	222 168				192	38	58		199	61	77		78 190	67 73	72 85
Quince A.	5	1,369	90	34.6	5	1,878	11.1	27.2	5	1,383	61.1	77.5	5	865	74.4	78.3
" B.	5	1,397	75	33.6	5	1,133	20.0	60.4	5	1,031	30.7	65.5	5	862	66.7	73.2
" C.	5	717	98	52.3	5	589	15.3	31.7	5	460	42.9	66.0	4	209	81.6	86.2
" D.	10	1,422	93	37.3	—	—	—	—	—	—	—	—	9	1,772	78.5	87.4
Average*	A,B,C. D.	226 142				240	15	40		192	45	70		138 197	74 79	79 87
SUMMARY FOR THINNED AND MATURE FRUITS TOGETHER.																
Quince A.	5	2,836	74	32.4	5	3,547	19	43	5	2,779	70	79	5	1,351	70	73
" B.	5	2,227	69	29.6	5	1,871	38	65	5	2,222	46	73	5	1,374	62	66
" C.	5	1,657	91	50.6	5	1,060	23	39	5	855	47	68	4	297	80	87
" D.	10	3,098	81	33.8	—	—	—	—	—	—	—	—	9	3,486	76	86
Average*	A,B,C. D.	448 310				432	27	49		390	54	73		216 387	71 76	75 86

NOTE. For details concerning sprays, see text.

* Crop averages given in number of fruits *per tree*.

Hydrated-lime Bordeaux was less effective than the burnt-lime mixture in 1931. Inadvertently, however, both mixtures were deficient in lime in that year (at "white-bud" and petal-fall), and while the hydrated-lime mixture caused considerable damage to the fruits, that made with burnt-lime was even more harmful, for it caused severe leaf-burn also. The spray causing the more damage thus gave the better Scab-control.

With regard to cropping, there was considerable reduction (average, 53 fruits per tree) on trees sprayed with burnt-lime Bordeaux mixture compared with the controls (average, 119 fruits per tree). The hydrated-lime mixture caused no reduction. Indeed, more fruits were borne by sprayed trees (average, 179 per tree) than by controls (average, 148 per tree). Some loss probably would be caused on the latter by early Scab-infection. The loss on trees sprayed with burnt-lime Bordeaux undoubtedly was mainly due to blossom-injury caused by the pre-blossom application.

The effect that the stock has on susceptibility to Scab in the scion was well shown by the figures for infection on control trees. Trees "worked" on Quince C were much more susceptible than those on Quince A, B or D. Stock-effect on susceptibility to Scab in apples has already been investigated on Cox's Orange Pippin (1, 2).

There was also very strong evidence that trees "worked" on Quince B showed a reaction to spray treatment different from that shown by those on the other stocks. Bordeaux mixture was less fungicidal on trees on Quince B (Eff. I, 77; Eff. II, 67) than on those on Quince A (Eff. I, 96; Eff. II, 96) or on Quince C (Eff. I, 88; Eff. II, 88), although Quince B (Scab-Equiv., 25.1) induced more resistance than Quince C (Scab-Equiv., 39.2).

1932. The use, pre-blossom, of lime-sulphur (1-30) in 1932 instead of colloidal sulphur (0.8%) as in 1931 (in each case followed by colloidal sulphur (0.4%) twice, post-blossom), resulted in great improvement in early Scab-control, as shown by the thinned fruits from trees on Quince A. This result was not confirmed by those from trees on Quince C, where the crop, however, was much smaller. The average for thinned and picked fruits together shows no decrease in the *proportion* of fruits scabbed in 1932 (Eff. I, 27) compared with 1931 (Eff. I, 31), but it shows definite decrease in the total *area* of Scab-spots in 1932 (Eff. II, 49) compared with 1931 (Eff. II, 38). Evidently, better control of early infection in 1932 was offset to some extent by greater late infection in that year than in 1931. On the whole, however, lime-sulphur pre-blossom followed by colloidal sulphur post-blossom was not a satisfactory spray-programme.

Lime-sulphur (applied three times) was not as effective in 1932 (Eff. I, 54; Eff. II, 73) as in 1931 (Eff. I, 76; Eff. II, 83). However, this spray caused no damage in 1932, when the strength for *both* post-blossom applications was reduced to 1-100.

As in 1931, burnt-lime Bordeaux mixture (Eff. II, 75) gave a similar result to lime-sulphur (Eff. II, 73) where Scab-areas were the basis of assessment, though the *proportion* of fruits scabbed was much greater with lime-sulphur (Eff. I, 54) than with the Bordeaux (Eff. I, 71). Again, then, Bordeaux mixture proved to be the more valuable spray for Scab-control on account of the greater percentage of clean fruits it provided. Where red-spider is prevalent, however, it would be profitable to use lime-sulphur for its dual value as fungicide and acaricide. Bordeaux mixture does not control red-spider.

Hydrated-lime Bordeaux mixture was more efficient than the burnt-lime mixture in 1932, although the difference between the two was not as great as it was in the reverse direction in 1931. The hydrated-lime mixture is the easier to prepare, and it is less likely to block nozzles owing to the absence of the grit sometimes found with burnt-lime after slaking. Hence its use should be preferred to that of the burnt-lime mixture.

Neither mixture caused damage in 1932 (for the cause of injury in 1931 had been investigated and rectified), but it will be observed that the average crop from trees

sprayed with burnt-lime Bordeaux (216 fruits) was less than one-half of that from controls (448 fruits). Undoubtedly this was the result of the severe foliage-damage and consequent interference with fruit-bud formation in the previous year. A similar effect of Bordeaux mixture has been noted on the Cox's Orange Pippin apple (1, 2). The average crop on trees sprayed with hydrated-lime Bordeaux (387 fruits) was greater than that on controls (310 fruits).

Fewer fruits were produced also by lime-sulphur-sprayed trees (average, 390) than by controls (average, 448). As no fruit-drop was observed during the summer, this reduction was probably due to damage caused by the petal-fall application at 1-60 in 1931, when fairly severe leaf-burn resulted.

The total crop on all trees in 1932 was very much greater than in 1931. This is probably an instance of "biennial bearing".

Stock-effect on Scab-susceptibility in the scion was again shown by the controls, and was similar to that in 1931 in that Quince C induced greater susceptibility than either Quince A, B or D. The degree of infection was greater on the whole in 1932 than in 1931, owing to the occurrence before blossoming in 1932 of weather conditions specially favourable to the fungus.

Burnt-lime Bordeaux mixture was again less effective on trees on Quince B (Eff. I, 62; Eff. II, 66) than on those on Quince A (Eff. I, 70; Eff. II, 73), or on Quince C (Eff. I, 80; Eff. II, 87), thus confirming similar observations made in 1931.

THEORETICAL CONSIDERATIONS CONCERNING THE ACTION OF SULPHUR.

The figures have so far been demonstrated mainly to show the greater commercial value of Bordeaux mixture than of lime-sulphur where only Scab-control is concerned. Although fewer Bordeaux-sprayed fruits were scabbed, the spots must necessarily have been of larger individual area than on lime-sulphur-sprayed fruits because the total areas in each case were approximately the same, taking the average of thinned and picked fruits together. Further analysis of the *scabbed* fruits in 1932 confirms this assertion.

Fertility. 1932.		Percentage of Scabbed Fruits in Grades :			Spray.
		Light.	Moderate.	Heavy.	
On Quince A	Thinned	63	18	19	Bordeaux
		75	18	7	Lime-sulphur
	Picked	72	12	16	Bordeaux
		85	8	7	Lime-sulphur
On Quince B	Thinned	65	22	13	Bordeaux
		79	13	8	Lime-sulphur
	Picked	65	16	19	Bordeaux
		83	11	6	Lime-sulphur
On Quince C	Thinned	81	6	13	Bordeaux
		69	21	10	Lime-sulphur
	Picked	73	3	24	Bordeaux
		75	9	16	Lime-sulphur

It will be seen that, whether the fruits were thinned or picked, there was always a greater proportion of scabbed fruits in the "heavy" grade (i.e. heavily-scabbed)

with Bordeaux mixture than with lime-sulphur. A similar result was obtained in 1931.

Scab-spots of large individual area are almost invariably due to early infection, and they distort the fruit. Later infections normally are smaller (they have less time to grow, and, furthermore, the older the fruit the more resistant it is (3)) and they do not appreciably distort the fruit because they occur after much of its growth has taken place.

The large spots on Bordeaux sprayed fruits are accounted for by the "missing" of fruits, or parts of the surface of fruits, by the spray during the earlier applications. It will be recalled that the plot was closely planted. Furthermore, spraying had sometimes to be done in a strong breeze. These conditions were not ideal for obtaining perfect "cover". As all the trees were sprayed by one operator, however, there is good reason for assuming that just as much indifferent "cover" was obtained with lime-sulphur as with Bordeaux, yet fewer large infection-spots resulted.

It seems likely, therefore, that at least the early lime-sulphur sprays exerted a toxic action towards the fungus at localized points on certain fruits where no spray had actually been deposited.

Much has been written from time to time on the possible fungicidal action of sulphur "at a distance". It is tentatively suggested that the present result might be due to the same action* under field conditions, although this is at present merely a working hypothesis and further work will be necessary finally to establish the point. Indications of a similar nature have also been found in results on apples, but these data have not yet been published.

Colloidal sulphur did not show this property of causing reduction (by possible action "at a distance") in the number of large, "early" infection-spots as lime-sulphur did. Comparison between Tables I and II illustrates this point. Colloidal sulphur on trees on Quince A in 1931 (see Tabular Summary) showed Efficiency I, 20 and Efficiency II, 0. In 1932, when lime-sulphur (1-30) was used preblossom instead of colloidal sulphur (0.8%), Efficiency I on the same trees was 19 while Efficiency II was 43. The inclusion of lime-sulphur, therefore, did not cause reduction in the *proportion* of scabbed fruits, but the *area* of the Scab-spots was considerably lessened. This was due to better control of early infection, as will be seen by comparing Efficiencies II (-31.8 in 1931, 59.3 in 1932) on *thinned* fruits (on Quince A) in each year. That the *proportion* of unscabbed fruits also was not reduced in 1932 has already been explained (see page 105).

SUMMARY.

An account is given of spraying experiments in Pear Scab-control carried out in 1931 and 1932 on the variety "Fertility", worked on different Quince rootstocks. Colloidal sulphur, lime-sulphur and Bordeaux mixture, each with lead-arsenate, were the fungicides compared. Three applications were made, at "white-bud", petal-fall and three weeks later.

Bordeaux mixture and lime-sulphur both gave good "commercial" control, but Bordeaux mixture kept more fruits clean by better control of late infection. Colloidal sulphur was not satisfactory.

Certain results were obtained suggesting the action of sulphur "at a distance" under field conditions.

Rootstock-influence on Scab-susceptibility in the scion was shown, as with apples, and a differential response of rootstock to Bordeaux-spraying was indicated.

* Only a short distance in terms of millimetres is visualized in this connection.

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ENTOMOLOGY

NOTES ON INSECT PESTS AND MITES IN 1932

By A. M. MASSEE

I. THE BROWN AND GREEN LEAF EATING WEEVILS.

The Brown Leaf Eating Weevil (*Phyllobius oblongus* L.) and the Green Leaf Eating Weevil (*Phyllobius maculicornis* GM.) are two of the commonest species of the genus *Phyllobius* which occur on fruit trees and bushes during May and June.

These weevils emerge from the soil about the same time as many varieties of apples (i.e. Cox's Orange Pippin) are in full bloom. On emergence the weevils make straight for the flower trusses, which they reach by either crawling up the stems of the trees or by flying on to them. On sunny days the weevils are extremely active.

They attack the flowers and leaves of apples, pears, cherries, plums, nuts, oaks, hawthorns, and apple and plum stocks in the nursery beds.

In some seasons the weevils are so numerous that they devour a large percentage of the petals of apple flowers; cordons and small bush trees being especially subject to attack. The reproductive organs of the flowers are also attacked, and when the infestation is very severe, the fructification of the flowers does not take place.

Probably the worst type of damage occurs in the nursery beds, bedded apple stocks and one year layers being very susceptible to attack. The weevils feed upon the developing leaflets as soon as growth commences, causing the stocks to become stunted, and very much weakened.

In 1932 these weevils were reported from East Malling, Maidstone, Canterbury and Southfleet.

Spraying with arsenical washes or dusts does not seem to check the weevils sufficiently to warrant their use. Some good can be obtained by jarring the weevils off the trees on to tarred boards. Fortunately the weevils fall very readily when disturbed. In the future it will probably be found that an application of derris dust will prove efficient against these weevils.

Other species of weevils contained in the same genus also cause similar damage, but they are not nearly so common as the two referred to above.

2. THE PEAR MAGDALIS.

The Pear Magdalis (*Magdalis barbicornis* LT.) was sent to East Malling during December, 1931, from Jersey, Channel Islands.

It was found attacking pear trees of the variety Doyenne du Comice, and was considered to be causing considerable damage to them.

The Pear Magdalis is very rare in Great Britain, and only odd specimens appear to be represented in the British Museum. It is found on the Continent, and it is regarded as being locally common in the Channel Islands.

According to Fowler, an authority on the Group, it is found in hedges, etc., attached to certain Rosaceae. The larva has been found in the branches of *Malus communis*. Some years ago it occurred at Wimbledon, Darenth, Hastings, Portsmouth and the Forest of Dean. More recently it has been found at East Malling on pears.

The weevil is dull black in colour, and is from 2-3 mm. in length.

The adult weevils feed on the undersurfaces of the pear leaves during May and June. The damage caused to the foliage by the feeding of the weevils is very characteristic. They feed upon the epidermal layers of the undersurface. The eaten areas turn brown, and since they feed for long periods on one portion of a leaf, lots of little punctures are centred around one small area of the foliage. The affected areas on a leaf are often the size of a threepenny piece. Occasionally the weevils eat right through the leaf, giving it a shot hole appearance, similar to that produced by Bacterial Die Back. The weevils do not appear to feed after the middle of July. The larval stage of the weevil is of interest. It lives under the bark, in a small cavity which is hollowed out for the purpose. The cavities or "chambers" are unlike those of many of the true wood boring beetles, because they do not connect up, and the insect does not make tunnels in all directions within the stems. Each larvae seems to be confined to its own home, which is isolated. The larvae remain in these cavities all the winter, the adults emerging in the Spring. The main stems and older wood seem to be attacked most generally, while the one and two year growths are rarely infected. The writer is greatly indebted to Mr. Ronald S. Thomson for bringing this interesting weevil to his notice.

3. THE APPLE BLOSSOM WEEVIL.

The Apple Blossom Weevil (*Anthonomus pomorum* (L.) Curt.) has been very common during the past few years, and it has caused considerable damage to bush apple plantations in many parts of Kent. Although it was not so abundant in 1932 as usual (probably owing to the unfavourable weather during the egg laying period) it still gave real cause for alarm in many districts, especially where cordon apples are grown.

Some interesting observations upon this weevil were obtained in 1932.

Now it is well known that many kinds of insects are more active after nightfall than during the daytime. These insects are able to feed without being attacked by birds or parasitic insects. Amongst these "nocturnal" insects a number of fruit pests may be mentioned. For example, various species of moths and beetles, such as the Winter Moth, and the Clay Coloured Weevil. The Apple Blossom Weevil is also more active after nightfall than it is during the daytime.

By the second week of June, 1932, the majority of adult Apple Blossom Weevils had emerged from the "capped" blossoms, and isolated specimens could be seen on the trees, amongst the foliage, and resting upon the shoots and stems. However, it seemed curious that so few weevils should be present, especially upon trees which were known to be badly "capped" by this insect during the blossom period a few weeks earlier. One likely explanation seemed to be that the majority of the weevils found shelter during the daytime amongst the loose bark, in crevices on the trees, and in the tufts of grass which are frequently found at the bases of the main stems. This theory has now been confirmed. It has been found that while the weevil population in an apple orchard may appear to be small during the daytime, they are really present in some numbers, but that they are in hiding, and that it is after nightfall that they may be found on the trees in considerable numbers.

It has been noted on many occasions that the weevils find their way to the trees by crawling up the trunks and also by flying on to the foliage after dusk. Once they reach the trees they feed quite readily upon the old and newly developing foliage. The feeding is characteristic, and it is quite distinct from that of many other apple leaf eating insects, but it may on occasions be mistaken for the damage caused by the larvae of the Apple Leaf Skeletonizer (*Hemerophila pariana* Clerck.).

The adult weevils feed on both surfaces of the foliage, causing small areas to turn brown, the attacked portions being completely skeletonized. This type of feeding was particularly noticeable in the season of 1932 and many orchards in the Maidstone district, Marden, Southfleet, East Farleigh, Kent, and in Peasmarsh, Sussex, showed definite signs of the weevil's work. Plate I, Fig. 2.

The damage caused by the larvae of the Apple Leaf Skeletonizer may be distinguished by the fact that frequently the whole leaf is skeletonized; also by the presence of the larvae, and by the presence of the little silken threads which the larvae make in the course of their work.

At 2 a.m. on the morning of 2nd July the branches of a tree of Rival were tapped and the weevils present were collected in a beating tray held underneath. The contents of the tray were emptied on to a white sheet, and more than 200 weevils were collected. Other trees were tapped with similar results. During the daytime adjacent trees were tapped, but only a very few weevils were found. This seems to indicate quite clearly that more weevils were present on the trees during the night, but generally speaking were absent during the daytime.

It is of interest to note that it is well known that the adult weevils feed on the developing foliage prior to the blossom period, and before they deposit their eggs, in the unopened flowers. However, this type of feeding is quite distinct from that referred to above. At the pre-blossom feeding period the weevils bore a hole right through the leaflet, leaving a distinct round hole, whereas after petal fall, a portion of the leaf is skeletonized, and the characteristic hole is not produced at this time of the year.

It has also been noted that the Apple Blossom Weevil is very susceptible to injury when it comes into contact with a derris dust. In one experiment some trees were dusted lightly with a derris dust. White sheets were placed under the dusted trees, and amongst the insects collected from the sheets were a large number of Apple Blossom Weevils. The weevils were not killed by the dust, but it was noticed that many of them were paralyzed and unable to move about with any certainty. The wing cases of the weevils frequently turned inside out, with the wings extended, and the legs were partially paralyzed. When they attempted to walk only the fore and intermediate legs were used, while the hind pair would be dragged along in a disconcerted manner.

The weevils remained in this state of semi paralysis for a period of ten days. After that many of them appeared to recover and behave in a normal manner. More than 200 weevils were kept under observation in tins, and those which had come into contact with the derris dust all behaved in the manner described above.

Now, the fact that the weevils are affected by the derris dust for a period of ten days suggests that a new method of control is worthy of trial. This year (1933) it is proposed to test whether it will be possible to apply dusts to trees usually infested by this pest (before they deposit their eggs in the blossoms), and thus deter the weevils from laying their eggs before the blossoms open. It is known that once the blossoms commence to open, the weevils are unable to deposit their eggs in them.

4. THE APPLE FRUIT SAWFLY.

The Apple Fruit Sawfly (*Hoplocampa testudinea* Klug.) which is considered to be one of the most serious pests of apple was very troublesome again during 1932.

The life-cycle of this pest has been worked out in some detail, but despite this fact, the measures recommended for its control are still far from being entirely satisfactory.

It was stated many years ago by Ormerod, Theobald and others that the larvae of this Sawfly may "strike" more than one apple fruitlet, and that all the apples in one

truss may be damaged by a single larva. The statements of these authorities seem to have been taken for granted, but nobody seems to have explained when and how the secondary attacks upon the fruitlets take place.

In 1932 it was possible to make observations on this aspect of the life-cycle of the Apple Fruit Sawfly.

It is well known that the egg of the Sawfly is deposited just below the calyx, when the apple flower is fully open. The larvae hatches some eight to ten days later, and then enters the developing fruitlet. The small larvae are very seldom seen during the daytime because they feed inside the fruitlets. At night, however, the larvae do not always stay inside the apples. It has been observed at East Malling Research Station and on two neighbouring farms that the larvae of all stages may leave the fruitlets at night, and walk about on the surfaces of the fruits. This type of migration may well be expressed as "a temporary nocturnal migration." The larvae do not only come out and move about on the fruits, but they may also be found on the foliage and occasionally on the stems. The larvae commence the nocturnal migration soon after nightfall, but by far the greater number are to be found outside some two hours before dawn. At dawn they begin to go back into the fruits again, and by 7 a.m. very few remain outside. However, a few may be seen outside at all periods of the day. Frequently they re-enter the fruits by the same hole which they originally came out of, but very often they bore into sound fruits and thus destroy them. They are able to tunnel into sound fruits with great rapidity, the whole process lasting only a few minutes. When the larvae are wandering about on the foliage they may by chance find their way on to new trusses of fruits which were not attacked previously. These they enter and destroy. This phenomenon has been observed on more than forty trusses which were previously marked as being free from attack. This important observation in relation to the migratory habit of the larvae has been noted on eight varieties of apples.

The fact that the larvae come out at night suggested that a new method of control was worthy of trial, namely, the use of a dust at night. Some apple trees of the variety Rival were dusted with a derris dust, of known composition, which happened to be available.

The dust was applied by means of a hand duster on Wednesday, 22nd June, at 8 p.m. White sheets were placed under the dusted trees, while other sheets were placed under adjoining trees which were left as controls.

The weather proved to be bitterly cold for the time of the year (the temperature registered only 1° above freezing soon after midnight) but in spite of this a number of larvae came out as usual after dusk. The observations were continued each night, and after four nights more than one hundred larvae were removed from the white sheets under each dusted tree, while an average of twenty-three larvae were collected from each of the sheets under the control trees.

While it is not suggested that dusts may at some future date supersede the wet sprays now generally recommended for Sawfly-control, it seems likely that it may be possible to eradicate this pest still further by means of dusts applied supplementary to the wet sprays.

These preliminary experiments and observations are being continued on a larger scale in 1933.

5. THE PLUM FRUIT SAWFLY.

The Plum Fruit Sawfly (*Hoplocampa flava* L.) has existed in Kent for a number of years, especially in the Borough Green area, but during the last three seasons it has

gradually spread to other districts, and it is now a serious pest in the plum growing districts around Maidstone ; while it was recorded at East Malling for the first time in 1932.

Many varieties of plums are subject to attack, but the variety Belle de Louvain would appear to be more susceptible to attack than other sorts.

The Plum Fruit Sawfly seems to have a very similar life-cycle to that of the Apple Fruit Sawfly, and the larvae have the same habit of migrating from the fruits at night, as that already described for the Apple Fruit Sawfly.

It will prove a very serious matter if the Plum Fruit Sawfly extends its activities to some of the large plum growing districts of Kent, and therefore growers are requested to look out for this pest, and report its presence to some competent authority.

6. THE CODLING MOTH.

The Codling Moth (*Laspeyresia pomonella* L.) has been known to fruit growers for very many years, but it has not been a very troublesome pest in commercial orchards during the past ten years or more. Nevertheless it is always present, and it frequently causes considerable damage in cottage gardens and to apples on small-holdings.

During the last few years, since 1927, the Codling Moth has become more numerous and it may now be found quite commonly in the Maidstone district, Paddock Wood, Canterbury, Sevenoaks and in the West Peckham area. It is also common at Swanley and Southfleet.

The first brood Codling is controlled very effectively when an arsenical poison is included in the first post-blossom scab spray, but unfortunately many growers no longer follow the practice of adding lead to the post-blossom scab sprays. It is when the post-blossom lead spray is omitted that the Codling Moth becomes a nuisance.

The most disturbing point about the Codling Moth is the fact that the second brood occurs in this country from time to time. It was noticed at Paddock Wood in 1931 and again in 1932. The second brood attacks the fruits late in the season, at a time when the use of an arsenical spray is ruled out of the question, owing to the possibility of an arsenical deposit being left on the fruits.

When the Codling Moth is known to exist in an orchard every care must be taken to destroy the first brood by applying a post-blossom, Calyx, arsenical spray. Further control can be obtained by placing hay bands or corrugated cardboard bands around the tree trunks in August. These should be removed and destroyed before the end of December.

7. THE APPLE FRUIT MINER.

The Apple Fruit Miner (*Argyresthia conjugella* Zell.) was recorded as an apple pest in the West of England nearly forty years ago, but it has not been very common in the fruit growing areas of Kent until fairly recently. It has been recognized as a pest in Scotland for many years.

Three years ago the Apple Fruit Miner was noted at Canterbury, and during the past two years it has turned up in other districts as well.

The damage to the apple is caused by the minute larvae of a species of Tineid Moth. The larvae tunnel into the fruits in all directions, causing an internal breakdown, and rendering the fruits worthless. Plate I, Fig. 1.

The natural host plant of the larvae is said to be Mountain Ash, and it is considered by some authorities that the apple fruits are only attacked in seasons when the berries of the Mountain Ash are not available for the insect to feed upon.

Under natural conditions the larvae leave the fruits in the autumn and go into the soil. They spin a small silken cocoon in which pupation takes place.

No control measures have been devised at present, and owing to the late period during which the fruits are attacked, any reliable control measures may prove difficult to carry out in the field.

8. THE APPLE SURFACE EATING TORTRIX.

The Apple Surface Eating Tortrix (*Batodes angustiorana* Haw.?) is by no means a new apple pest, but curiously enough it has been very largely overlooked in the past. In recent years, when the advent of the cold store came into being, this small moth has been looked upon as a very troublesome pest indeed. The fact that for cold store purposes apples must be selected which are free from blemishes has brought this insect to the fore.

The larva of this small Tortrix Moth feeds upon the surfaces of the fruits during the latter part of August and in September. One characteristic of the larvae is that they frequently stick or attach a leaflet to an apple which is still growing on the tree; and live and feed in a sheltered position between the leaflet and the apple surface. The larva is of a light yellowish-green colour, with the head and second segment black.

Many of the larvae still remain on the apples when they have been gathered, and they continue to feed upon the fruits while they are standing in the packing shed or being passed through the graders. Another serious aspect is the fact that feeding continues under the influence of the cold store, which eventually results in soft rots setting in and destroying the fruits.

The larvae do not tunnel into the fruits in the same manner as the Apple Fruit Miner, but they merely feed upon the epidermal layers, usually around the strig end or near the eye of the apple. However, any part of the surface may be attacked. See Plate II. It is common to find a small silken web neatly attached to the eye of the apple. If the web is disturbed a small wriggling larva will be noticed under it.

In 1932 this insect was so numerous that 50 per cent of the apples from a Bramley orchard at East Malling were damaged by this pest. It was equally common elsewhere in Kent.

The larvae proved to be so common in one cold store in Kent, that literally thousands could be seen moving about on the floor, walls, fruit and in the apple boxes. In addition, many were suspended on fine threads from the ceiling.

The life-cycle of the moth has not been thoroughly worked out under local conditions, but one or two points of interest have been observed. Under natural conditions the larvae pass the winter in the apple orchard. They often attach themselves to a spur or bud, being concealed under a piece of dead leaf which is securely fixed to the stem or bud. This form of hibernating larva is very difficult to detect at first, but when one becomes accustomed to looking for their little hiding places they will probably be noted in some numbers. Occasionally the larvae fall to the ground and hibernate in the dead leaves, while others hibernate in cracks in the stems. The larvae become active again in the spring as soon as the trees commence to produce growths. Under the circumstances it is curious that the larval forms are not sufficiently controlled by the application of the winter tar-distillate, combined with the arsenical sprays which are used as a matter of routine in the spring. However, in practice it has been found that this pest is increasing and the present methods adopted for general pest control do not control the Fruit Surface Eating Tortrix sufficiently, and other methods of control will have to be worked out.

Other species of Tortricides also cause similar damage to apple fruits, but it is thought that the *Batodes* sp. is the more common.

9. THE HOP RED SPIDER.

The Hop Red Spider (*Tetranychus telarius* L.) is always present in some number wherever hops are cultivated, but it is only on rare occasions that it becomes a pest of real economic importance.

For several years past this mite has been a serious pest in a number of hop gardens situated at Cuxton, Kent.

Each Summer from the end of June until September the damage caused by the mite is apparent, and every year the vines suffer considerably in spite of several sprayings with liver of sulphur, applied at the maximum strength of 1 lb. per 100 gallons of water.

The hops in these gardens are trained up poles and it would seem that this old-fashioned method of growing hops is partly responsible for the regular outbreaks of the Hop Red Spider.

An examination of some of the poles in the winter of 1932-33 revealed the fact that an enormous number of mites hibernate in the cracks and crevices of the poles. Some of the poles were split open, and long rows of the red hibernating forms of the mites were observed. The mites usually congregate in colonies in the cracks in the poles. It is odd that the majority should be found towards the tips of the poles. Possibly this may be explained by the fact that in the autumn, just before the vines are pulled down, the mites are most frequently found at the tips of the vines. During cold weather the mites would automatically seek shelter at the first convenient place, which would be at the apex of the poles.

An attempt has been made to destroy the hibernating mites in the poles by treating the poles with a white oil emulsion. However, it is yet too early to state how successful this measure of control will prove to be.

10. THE WOOLLY APHIS PARASITE.

Further attempts to establish the Woolly Aphis Parasite (*Aphelinus mali* Hald.) have been made in badly infested apple orchards situated at East Malling and Paddock Wood, Kent.

The parasites placed in the orchard at East Malling in the Spring of 1931 lived all through the summer, and they actually survived the winter of 1931-32. The parasites were active again in the summer of 1932, but they did not appear to travel very far from the trees where they were first established.

The parasites liberated in the orchard at Paddock Wood in the spring of 1932 also established themselves during the summer, and by the end of September they had spread over an area of some two or three acres. While it must be said that all the woolly aphis present was not parasitized, it was noticeable that the parasite considerably checked the spread of the woolly aphis, which in fact was much less common in the orchard than last season.

The parasites which were established in a severely woolly aphis infested apple orchard at Chislehurst several years ago, are difficult to find in the orchard at the present day. After the parasites had very nearly wiped out the woolly aphis, they disappeared and very few have been noted since. However, odd parasitized woolly aphides were noted in the orchard during the first week of March, 1933. It is proposed to make a survey of the apple plantations in the neighbourhood to determine whether the minute parasites have migrated in order to find fresh food for their requirements.

The Woolly Aphis parasite investigations have been carried out jointly by Mr. A. S. Buckhurst, of the Ministry of Agriculture's Plant Pathological Laboratory, Harpenden, and the Entomological Section at East Malling. The parasites are bred and supplied by the Ministry.

SUMMARY.

Notes are made upon ten insect pests, mites and a parasitic insect noted in the year 1932. Among the more important pests observed were the Apple Fruit Sawfly, the Apple Blossom Weevil, the Apple Fruit Miner, the Apple Surface Eating Tortrix and the Plum Fruit Sawfly.

Some observations upon the parasite *Aphelinus mali* are also briefly referred to.

PLATE I

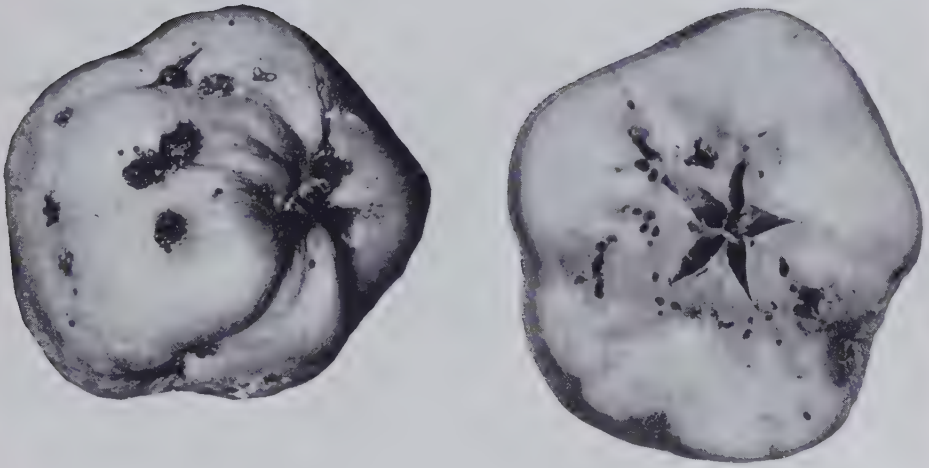


FIG. 1. Left : Damage caused to the variety Lord Derby by the Apple Fruit Miner (*Argyresthia conjugella* Zell.). Right : A section of the same fruit. (Two-thirds natural size.)

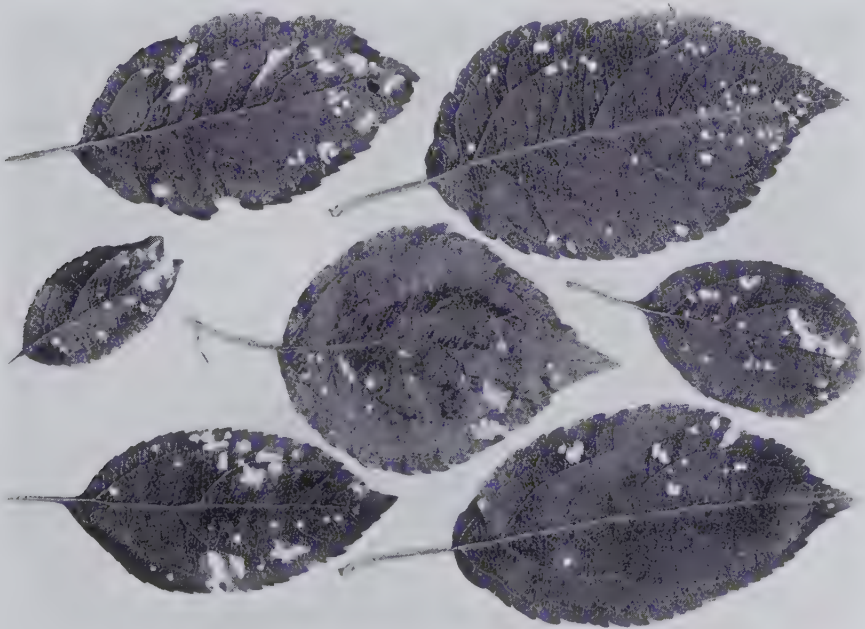
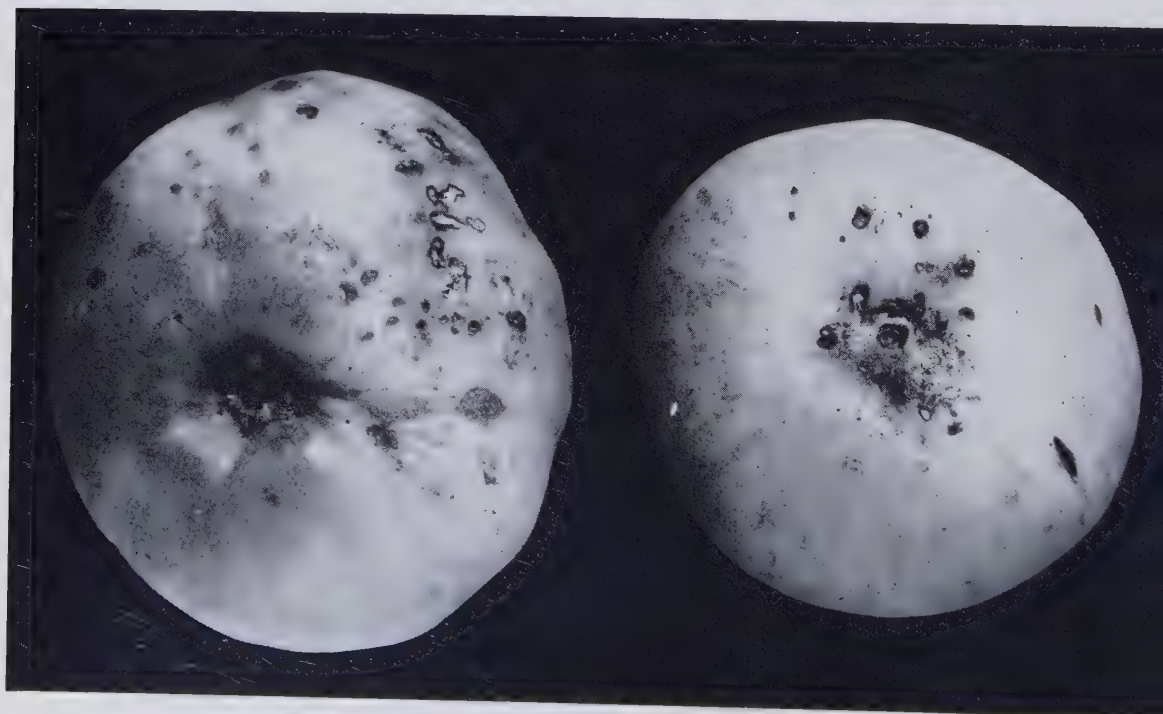
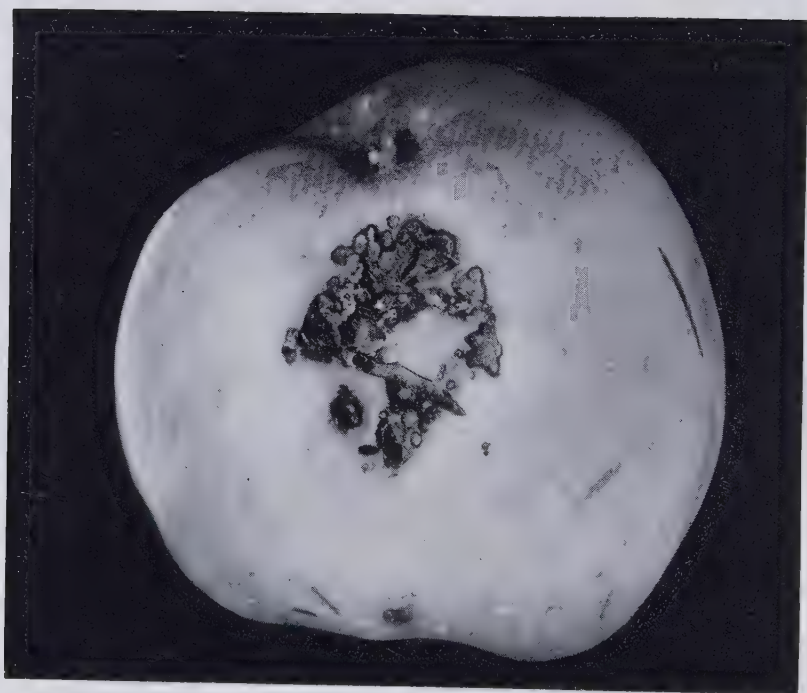


FIG. 2. Damage caused to the foliage of Bramley's Seedling apple by the feeding of the adults of the Apple Blossom Weevil (*Anthonomus pomorum* (L.), Curt.). (Three-fourths natural size.)

PLATE II



Damage caused to Bramley's Seedling Apples by the larvae of the Apple Surface Eating Tortrix (*Batodes angustiorana* Haw. ?). (Two-thirds natural size.)

FURTHER OBSERVATIONS ON THE STRAWBERRY TARSONEMID MITE

(*TARSONEMUS FRAGARIAE* ZIMM.)

By A. M. MASSEE

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INTRODUCTION.

The first authentic record of the occurrence of the Strawberry Tarsonemid Mite in this country was published in February, 1930 (10), but at that time it was not known whether it was of economic importance.

During the past three years it has been studied by a number of Investigators in this country, and at the present time it is generally agreed that it may be of considerable economic importance to the strawberry grower. In addition, it has been ascertained that the mite is very widely distributed in Great Britain, and that a number of well known commercial varieties are subject to attack.

This mite has also been recorded from nine other European Countries, and it is regarded as being a serious pest of the strawberry in Germany, Denmark, Norway and Sweden.

Even now, however, it is not claimed that the Strawberry Tarsonemid Mite is the primary cause of the widespread deterioration of strawberry plantations, which may be found all over the country to-day, but it is suggested that the mite is one of the many factors which account for this degeneration, which in turn has materially reduced the crops.

Various Investigators have shown that a number of insects and mites, such as the two species of Aphides, the Strawberry Red Spider, the Strawberry Eelworm, etc., may all occur on the strawberry plant, and under certain conditions, may cause serious harm. This may be so under certain circumstances, but it would be premature to suggest that any one of these insects is entirely responsible for the degenerate state of the strawberry plant at the present time.

DISTRIBUTION OF THE MITE.

(1) *Great Britain.*

The Strawberry Tarsonemid Mite (*Tarsonemus fragariae* Zimm.) is very widely distributed in this country. It has been recorded from all the counties in the South and West of England, and it occurs in the Midlands and the North. In Scotland it has been found in the Lothians and Lanarkshire, and it also occurs in South Wales.

(2) *Continental Europe.*

The same mite also occurs in many other European countries, and it is reported as being a serious pest by several well known continental authorities.

Although the mite was described by Zimmerman (30) so long ago as 1905, it does not seem to have attracted the attention of the economic Entomologist until seven years later. The first economic reference appears to be that of Schøyen (22), who discovered

the mite damaging strawberries in Norway in 1912, and found that it was widely distributed in that country by 1914. The mite also occurs in Germany (17), Switzerland (18), Finland (20), Russia (21), Holland (28), Sweden (29), Denmark (1), and Austria (20).

THE AMERICAN SPECIES.

During recent years several American and Canadian Entomologists have been interested in a species of Tarsonemid Mite which infests cultivated strawberries in those countries. Now since the symptoms of damage, caused by either the American or the European species were identical, it seemed desirable to compare specimens from both continents to determine whether they belonged to the same species.

Careful comparisons of the two mites made possible through the courtesy of Mr. W. A. Ross, Entomologist, Vineland Experimental Station, Ontario, Canada, by means of a compound microscope showed that though the two were similar, differences in the leg appendages proved that the mites from Canada were distinct from the English ones (27).

The Canadian species proved to be *Tarsonemus pallidus* Bks., a species well known in the United States and in Canada (35) which was described by Mr. Nathan Banks (31) in 1899. Although the American Strawberry Mite, or Pallid Mite, as it is called in that country, has been known for over thirty years, it does not appear to have been recognized as a strawberry pest until about four years ago, when Darrow (33) recognized it as being a field pest of the strawberry. It was also found on strawberries in the Ottawa district in 1929 by Ross and Caesar (37). The Pallid Mite has not been recorded in Great Britain, but it has been found in France (38), and is said to infest greenhouse plants.

HOST PLANTS OF *T. fragariae* ZIMM.

(1) *Great Britain.*

The strawberry plant appears to be the only host plant of the mite in this country. It occurs on both wild and cultivated varieties. In view of the possibility that other host plants may exist, but have been overlooked, frequent examinations have been made of wild plants growing in or close to strawberry fields, at different times of the year, but the mite has not been found on any of them.

Experiments have been carried out at East Malling to see whether the mites could be induced to live upon such plants as the Cyclamen, Begonia and the Raspberry, upon which the mite had already been recorded in different parts of Europe. The investigations were extended over three seasons, from 1930-1933, but negative results were obtained every time.

(2) *Continental Europe.*

In Continental Europe the Strawberry Tarsonemid Mite occurs on no less than six host plants. It has been recorded on the cultivated strawberry from eleven countries, all of which are mentioned below ; on the wild strawberry in Finland and on Begonia in Holland and Finland ; on raspberries in Norway ; on *Alchemilla vulgaris* in Russia ; and on Pelargonium and Cyclamen in Holland and Finland. When searching for mites on alternative host plants in this country, all the continental host plants were examined in detail, but as already indicated mites were not found.

There seems to be a general idea in the country, especially amongst gardeners, that a species of mite (frequently said to be a species of *Tarsonemus*) is the cause of the failure of Begonias and Cyclamen plants, which are grown under glass for ornamental purposes. The writer has obtained a large number of these so-called " Mite infested "

plants from various parts of England, but up to the present mites have not been found on any of them.

THE HOST PLANTS OF *T. pallidus* BKS.

The Pallid Mite also occurs on several host plants, some of which are the same as those recorded as hosts of the European species. They are as follows :—Wild and cultivated varieties of Strawberries, Chrysanthemums, Cyclamen, Geraniums, Antirrhinum spp., and the Perennial Larkspur (*Delphinium belladonna*). The Pallid Mite is considered to be a very serious pest of Cyclamen and Begonias as well as other ornamental plants which are grown under glass. It is of interest to note that the Pallid Mite also occurs in France (38) on Antirrhinums.

NOTES ON LIFE-CYCLE OF *T. fragariae* ZIMM.

The Breeding Season.

In common with many other species of mites, the Strawberry Tarsonemid Mite commences to breed during the spring and continues to do so during the summer and autumn months, whenever the weather conditions are suitable. The rate of reproduction increases materially during periods of prolonged hot, sunny weather. In Kent the adult females usually commence to deposit their eggs in the folds of the unopened leaflets, in the more sheltered positions of the plant, during the month of April. In the North of England the egg laying period is usually delayed until May, while in Devonshire and Cornwall the ova may be present on the plants as early in the year as February. The egg laying season continues throughout the summer months, and it is very often prolonged until the end of October or may even extend into November, as it did in the autumn of 1932. Therefore eggs are being laid over a period of six or seven months. Several generations of mites occur during the year, and there is a considerable amount of overlapping of the various stages. Thus, it is common to find the adult mites of both sexes, the various nymphal stages, and the eggs all scattered about on a single leaflet during the Summer months.

The Occurrence of the ♂♂.

The male Tarsonemid Mite is very much less common than the female, and it is often very difficult to find on the plants. It is more abundant during May than at any other period, and it has been observed that the mites copulate during that month. It is not known whether parthenogenesis occurs in this species, but this phenomenon seems probable, because the females continue to breed quite freely during periods when the males are very scarce. Parthenogenesis is thought to exist in a closely allied species, *Tarsonemus tepidariorum* Warb. which infests ferns (32).

The Eggs.

The elliptical, white, transparent eggs, which are just visible to the naked eye, are usually deposited in the folds of the unopened leaflets. They are commonly situated along the mid rib of the leaf, and are not laid in a regular pattern, characteristic of so many species of moths, but are always laid at random. However, the mite population may become so vast during the summer months, that of necessity the eggs are deposited at random on any part of the plant.

The Adult and Immature Mites.

The adult and immature forms also prefer the more sheltered parts of the plants, and it is evident that they object to direct sunlight. When the infestation is unusually

severe, however, they swarm all over the plants. On such occasions they move about very quickly, and it is more than likely that they are trying to seek the more sheltered parts of the plants, which are already overpopulated with mites.

The mites attack the upper surface of the foliage by piercing the epidermis and feeding on the tissue just below the surface. The actual punctures are not very conspicuous, but after some days they turn brown, and can then be seen by means of a hand lens. Mites have not been observed to feed elsewhere on the plant.

The Hibernation Period.

The mites hibernate on the plants in the adult female stage only, males, immature forms, and the eggs being absent during the winter months.

Hibernation usually commences in October and continues uninterrupted until the spring, but the length of the hibernation period depends upon the climatic conditions during the autumn months. Mites have not been observed hibernating in the soil or on parts of the plant below ground level, and it is believed that the whole of their life-cycle is spent on the foliage and crown of the plants. The mite population reaches its minimum during the winter months, and it is frequently very difficult to detect the over-wintering females which are hidden away in the crevices of the crowns of the plants. Moisture does not seem to affect them, since they are frequently found tucked away in the crowns of the plants which are in a very damp condition.

Dissemination of the Mites.

Very little is known about the dissemination of mites in general, and still less is known about the movements of the Strawberry Tarsonemus. Many detailed observations have been made upon this important aspect, but little progress has been made.

The mite does not appear to be carried about by insects to any marked extent. A large number of insects, which had previously been in contact with mite infested strawberry plants, have been examined, but mites have been found attached to their legs or bodies only on rare occasions. Two Spot Lady Bird Beetles were placed on mite infested strawberry plants, and were allowed to roam about. After some time they were examined, but no mites were found attached to them.

Two mites were found attached to the legs of the Strawberry Aphis (*Capitophorus fragariae* Theo.) and one clinging on to the elytron of the Seven Spot Lady Bird Beetle (*Coccinella 7-punctata* L.), and these were the only examples noted so far.

Mites have not been observed to travel from one plant to another on the soil surface, and some observations made upon a number of badly infested plants, growing in pots under glass, tends to show that they do not migrate by this means. The plants were very severely infested, and the mites were moving about in all directions on the plants, but they did not leave the plant and walk about on the soil. Some infested leaves were removed from the plants and placed on the soil and directly the leaves started to wilt the mites left them and went back to the growing plant. Their minute size would certainly make difficult their detection when on the soil, yet when it is realized that some hundreds of thousands may occur on a single plant it should be possible to detect at least odd individuals if they migrated by way of the surface of the soil.

Probably the most important method of migration, at least from the economic aspect, is that which may well be called "a natural migration" of the mites from the parent plant to the runners. This mode of migration is important because it means that once an established plantation has become badly infested, it will not be safe to propagate the progeny from the same field, unless the young plants are treated in some way, because they too will almost certainly be infested. The natural migration of the

mites from the parent plants to the runners commences directly the runner stolons begin to grow, and frequently before the runners have commenced to produce their rootlets. By the time the young plants become self-supporting, the mites are well established and have commenced to breed; and the plants are severely injured and retarded so that they frequently die. (See Fig. 5.) It still remains a mystery how the mites migrate under glasshouse conditions.

A number of experiments have been carried out at East Malling under glasshouse conditions, and in each case it was essential to keep the plants growing in a healthy condition, free from mite and insect infestation. The strawberries were growing in pots, and were considered to be in a healthy state when planted. Several precautions were taken to prevent them from becoming infested. Each pot was greased to prevent mites walking up the sides, and the foliage of one plant was not allowed to touch that of another. In addition, the plants were sprayed regularly with suitable acaricides.

As a result of these precautions a majority of the plants remained healthy and mites could not be found on them. Then suddenly, and without any apparent reason, a severe outbreak of mite would be detected on a number of plants which had been kept under close observation for eight months. It is difficult to conceive that the mites were present on the plants all the season in a dormant state, because the conditions were suitable for their breeding purposes. In fact the mites had a better chance to breed earlier, before the plants had been sprayed so many times, but when the infestation was actually detected, the plants in question had been sprayed eight times. It is believed that the mites came into the greenhouse from some outside source, and it is not known how they reached the plants.

The possibility of mites being borne by the wind has been considered. A number of greased boards were placed at intervals amongst some badly infested strawberry plants. The greased surfaces of the boards were examined periodically, though many small winged insects were found to be trapped, but mites were not noted at any time during the season.

The mites migrate very slowly under natural conditions in the field. This phenomenon was first observed in a strawberry field at East Malling, when a row of Royal Sovereign plants, consisting of several hundred plants, was kept under constant observation. In 1929 it was found that only about 20 per cent of the plants were infested, and it was not until the latter part of 1932 that the infestation had spread along the row until every plant was attacked. The mites were noted to spread along the row in patches, and it is significant that the plants which had become isolated in the row, owing to the death of plants on either side, were the last to become infested.

TYPES OF DAMAGE.

Established Plants.

The description and diagnosis of the symptoms of direct mite injury to the strawberry plant are rendered difficult because a number of animals associated with the strawberry plant produce types of injury similar to that caused by the mite. When the mite infestation is inconsiderable the plant does not differ in general appearance from a healthy one, and the mites can only be found after a careful search has been made for them amongst the small, unopened leaflets.

The symptoms which are more obvious when the infestation is severe (II), may be best described for the variety Royal Sovereign. The foliage at first changes in colour from the normal fresh green hue to a duller yellowish-green and as the infestation becomes more severe, the sickly yellowish-green appearance of the leaves becomes correspondingly more obvious. Another characteristic is the extreme brittleness of the developed

leaves. They become brittle when they have fully expanded but the young leaves do not exhibit this phenomenon. The attacked leaflets also become distinctly crinkled and distorted, and the margins turn inwards. (See Figs. 1 and 2.)

When the infestation is considerable the young unopened leaflets of the established plant turn brown in colour and dry up before they have time to expand. (See Fig. 3.) This type of injury tends to make the plant produce an abnormal number of weak growths arising from the crown, and these usually develop slowly, producing small, malformed leaves. It is quite common to find a number of normal leaves on a badly infested plant, which may be accounted for by the fact that a few leaves are produced by the plant during the period when the mite is not active, or when the mite population is comparatively small.

Runners.

It has been explained elsewhere that a natural migration of mites from the parent plants to the developing runners takes place as soon as the latter commence to grow during the summer months. This kind of infestation is undoubtedly the most serious, because the mites establish themselves on the young plants, before the plants are vigorous enough to withstand the attack. During a period of hot weather, a large percentage of the runners may be destroyed by this type of infestation, and the mortality being caused by a combination of direct mite injury and the hot weather conditions, both of which are unfavourable to the plant.

The mites migrate along the stolons, and establish themselves at the nodes, where the plants will eventually develop. They commence to infest the stolons when they are barely half an inch in length, and by the time they have attained a length of some two or three feet the mites are firmly established upon them. (See Fig. 4.)

When a runner is badly infested, all the unopened leaflets arising from the crown of the plant may be attacked, and when this happens, they turn silvery-brown in colour. This type of injury is very characteristic, and it has been referred to as the "mouse ear" stage of attack. It is so-called because the leaflets turn brownish-grey in colour, while the pubescence and hairs turn a silvery-white, the whole somewhat resembling a Field Mouse's ear. When the infestation reaches the "mouse ear" stage the plants frequently die. (See Fig. 5.)

THE EFFECT UPON THE PLANTS.

It has been stated already that the runners may be killed by direct mite injury. This usually occurs when the weather conditions are unfavourable for the development of the plant, and are particularly suitable for the breeding of the mites. On the other hand, when the weather is cold or when the conditions are unfavourable for the rapid reproduction of mites, the runners frequently grow away without being materially affected by the attack.

It is very unusual for established plants to be killed by the mites, but the effect they produce upon the growth and general vigour of the plants may be very considerable, the degree of damage caused being dependent very largely upon climatic conditions. If the weather is warm in the spring, the mites commence to check the growth of the plants in May, and the damage steadily increases until the end of October, by which time the plants are very unhealthy. Conversely, if the weather conditions are not favourable for the development of the mites, then the amount of damage they cause to the plants is comparatively small.

Experiments have been carried out in order to decide the very important question whether the effect of direct mite injury is a permanent one, or whether it is possible

that a severely infested plant can be induced to grow out again into a healthy, robust condition.

In April, 1930, twelve vigorous Royal Sovereign strawberry plants, growing in pots under glasshouse conditions were inoculated with mites, and infestation became so severe by August that the vigour of the plants was greatly reduced. At this stage, with considerable difficulty the mites were eradicated and the plants were re-potted to give them a fresh start. They were kept under observation during 1931 and mites were not found on any of them. The behaviour of these plants during 1931 was of particular interest. It was naturally expected that all the plants would grow away quite normally when the mites had been destroyed, but such was not the case. Seven plants developed in a normal manner, and considering their weak state during the previous autumn, the growth they made was remarkable. The other five did not make any new growth at all. They just survived, and were in a very unhealthy condition. By the end of July they had died. Mites were not present and in fact no form of animal life was recorded upon any of them, so that some factor other than mites or insects, must have been the cause of death. This matter will be discussed again at the end of this paper.

In more recent experiments it has been found possible to raise strawberry plants and keep them in a healthy condition when the mite factor has been eliminated, but it has been noticed that a number of plants do not exhibit the characteristics of normal growth and die in their second year. Of the plants that died, some thirteen had never been infested with aphides or mites.

Varieties Attacked.

The mite has been recorded upon the following varieties of strawberries, but it is quite likely that many more sorts are subject to attack. Royal Sovereign, The Duke, Laxton, Laxton's Noble, Stirlingworth, Stirling Castle, Madame Kooi, Oberschlesian, Sir Joseph Paxton, King George V, Bedford Champion and Laxtonian.

Royal Sovereign, King George V, The Duke and Sir Joseph Paxton are frequently very severely attacked, while the degree of infestation on such varieties as Oberschlesian, Madame Kooi and Laxtonian is usually slight. The other five varieties referred to in the above list fall into the intermediate group.

CONTROL MEASURES.

Preliminary Tests with Acaracides.

Some preliminary laboratory trials were conducted in 1929 and 1930 to determine whether such spray fluids as lime-sulphur and petroleum oils were toxic to the mites, since these sprays have well known toxic properties against other species of mites.

In the initial tests, some mite infested strawberry leaves were dipped in the spray fluids, which had been prepared at different concentrations, varying from 1 to 7 per cent. The leaflets were completely submerged in the fluids for a period of ten seconds, and were allowed to dry on removal.

Examination with a binocular microscope indicated that a 3 per cent lime-sulphur spray and a 2 per cent high grade white oil emulsion had a marked toxic effect upon the mites which however was not apparent until some fifteen to twenty hours after treatment. Higher concentrations of the spray fluids did not increase the toxicity. It was also found that neither the lime-sulphur nor the white oil was effective against the egg stage of the mite or the quiescent larval forms.*

* The immobile larval stage, just prior to the emergence of the adults. The quiescent stage only lasts for two or three days.

In further trials it was found that the efficiency of both sprays was increased when 1 per cent of commercial powdered spray gelatine was added to them. It is possible that the gelatine tends to stick the mites to the leaves, and that it helps the foliage to become wetted more readily.

Further preliminary tests were carried out on some badly mite infested Royal Sovereign plants growing in pots, under glass. The plants were sprayed with 3 per cent lime-sulphur and a 2 per cent high grade white oil, with the addition of .1 per cent of commercial powdered spray gelatine. The sprays were applied by means of a pneumatic hand sprayer, supplying a pressure of 100 lbs. per sq. inch.

Subsequent observations showed that mites were present on all the plants, whether they had received the spray treatment or not, and it gave a clear indication that one application of lime-sulphur or white oil spray was not efficient. The poor results obtained were probably due to two factors; the difficulty of directing the spray fluids into the folded leaflets where the mites live, and the fact that neither of these spray fluids affects the eggs, which hatch out in a normal manner after treatment. In addition the nymphal stages do not appear to be affected unless they are actually wetted by the sprays. In more recent experiments conducted in 1931 and 1932 it has been found that the mites breed so rapidly under glasshouse conditions that it has proved necessary to spray the plants not less than fourteen times in order to keep the mite in check. Even after this drastic treatment the mite was not wiped out.

In passing it is of interest to note that so many applications of sprays may cause serious harm to the plants. The spray soaks into the soil in the pots and partly destroys the roots of the plants, so that in order to avoid this unusual kind of spray injury, the pots were tilted after each spraying, to allow the spray residue to drain off the soil surface.

Field Spraying of Established Plants.

Since it is impossible to make individual counts of mites on sprayed and unsprayed plants, or to state definitely that mites are not present on any particular plant, considerable difficulty has been experienced in obtaining an estimate of the degree of reduction of the infestation, if any, following the various treatments. In one experiment an attempt was made to estimate the degree of infestation on various plots, but even this method is extremely difficult to put into practice when dealing with a pest of this nature.

A field spraying trial was carried out at East Malling in the Spring of 1931, on some two-year-old Royal Sovereign strawberry plants, which proved to be ideal for the purpose, because the mite infestation was general, being present on all the plants examined. Two applications of lime-sulphur were made, the formula being similar on each occasion, viz. lime-sulphur, 3 per cent; water, 97 per cent; commercial powdered spray gelatine, .1 per cent (12, 13, 14 and 15).

The first application was made on 15th and 16th April and the second on 29th April, the weather being fine on both occasions. The spray was applied by means of a Vermorel Cascade sprayer, at a pressure of 120 lbs. per square inch, and was directed into the crowns of the plants, no special effort being made to wet the older leaves.

The reason for spraying on these dates may be explained as follows. It was desired to spray as soon as the over-wintering female mites were noted to commence activities in the spring, but before they started laying their eggs. This date happened to be during the second week of April during 1931. The second application was made on 29th April, because by that time eggs were being laid quite freely, and it was desired to get the spraying completed before the egg laying was general.

Observations made during May and June showed that the plants were checked to some small extent by the double spraying treatment, but there was no injurious effect upon the crop. With regard to the effect of the sprays upon the mites very little can be said. Mites were present on all the plants, whether they had been sprayed or not, and it proved to be impossible to obtain any reliable figures for evaluating the spray treatment. However, it was evident that the treatment had some material effect upon the plants, for it was possible to pick out the various plots without difficulty. All the sprayed plants were in a healthier condition and this was no doubt partly due to the fact that the Red Spider Mite had been greatly reduced on the treated plots, while it proved to be very common on the unsprayed plants all the season, causing the foliage to turn a dull reddish-silvery colour. The treatment of mite infested strawberry plants has been undertaken by commercial growers on a field scale. In one case some four acres of Royal Sovereign plants were sprayed twice in the spring with a 3 per cent lime-sulphur, applied by means of a power sprayer, at a pressure of 250 lbs. per square inch. It was evident that the sprays had some material effect upon the plants, because it was possible to pick out the treated parts of the field from the area which do not receive any sprays. This has been observed in other plantations.

It would seem, therefore, that although the lime-sulphur treatment does not completely control the pest, it does reduce it materially and that until a complete remedy is found for controlling mite infestations in established plantations, it is still well worth while applying the two applications of lime-sulphur. This would seem to apply more especially when the Strawberry Red Spider Mite is also present on the plants, the lime-sulphur treatment being especially effective against this pest (16).

Applications of Dusts.

Preliminary experiments were made in 1931 and 1932 to determine whether sulphur dusts could be used in place of wet sprays for destroying the mite.

In the initial test flowers of sulphur was applied to the plants by means of a small hand duster. The plants received from one to five applications of dusts, an attempt being made to blow the sulphur down into the crowns of the plants. Negative results were obtained in all the preliminary tests. The chief difficulty seems to be that of getting the sulphur into the crowns of the plants and in contact with the mites in the folded leaflets. It is quite feasible that the routine applications of sulphur dusts which are applied on a commercial scale for the purpose of controlling Strawberry Mildew, may help to check the mite to some small degree, but it seems to be very unlikely that sulphur dusts, used alone, will control the pest.

TREATMENT OF RUNNERS BEFORE PLANTING.

Fumigation with Hydrocyanic Acid Gas.

Since it is obvious that mite infested strawberry runners must be treated in some way before planting them, it was decided to find out whether the fumigation of plants with hydrocyanic acid gas would prove to be an efficient method.

In October, 1930, some four hundred mite infested Royal Sovereign plants were dug up and allowed to dry off. It was essential to get the plants into as dry a condition as possible, without injuring them, since it is well known that the fumigation is more likely to cause injury when they are wet.

When comparatively dry, the plants were spread out on potato trays and were placed in a small fumigation chamber, with a cubic capacity of 176 cubic feet. The formula used was as follows: Sodium cyanide, 2 ozs.; sulphuric acid, 4 ozs.; water, 16 ozs. for each 1,000 cubic feet of space.

The plants remained in the fumigation chamber for a period of sixteen hours, and were planted immediately afterwards.

Ninety per cent of the plants died within a week of being planted, and the foliage of the remainder turned black and was in a very wilted condition, and all the plants had perished by the end of the year.

A second batch of 400 runners was fumigated during the last week of October, 1930, the strength of the cyanide being reduced by one-half. The formula was: Sodium cyanide, 1 oz.; sulphuric acid, 4 ozs.; water, 16 ozs. for each 1,000 cubic feet of space. However, it was found that the effect of the fumigation, even at the reduced strength materially affected the plants, and none of them survived the winter.

A further test was made in February, 1931. In this experiment the amount of sodium cyanide was reduced to half an ounce for each thousand cubic feet of space. Some four hundred plants were treated for a period of sixteen hours. The foliage showed definite signs of turning black the day following the fumigation, but the young leaves were not affected until some time later. Fifty per cent of the plants had died by May and the surviving plants were then examined, mites being found on all of them.

Further experiments were not attempted, since it was obvious that the plants were seriously damaged by the fumigation, even when weak doses of cyanide were used. In addition the mites were not affected by the treatment.

Lime-sulphur. Preliminary experiments were arranged in 1930 to determine whether the mites could be destroyed by immersing the plants in a lime-sulphur preparation before planting them. The initial tests were made with the object of determining whether the plants would be affected by the treatment, and to find out what strength of lime-sulphur could be used without damaging them.

In the autumn of 1930 four hundred Royal Sovereign strawberry plants were dipped in 3 per cent lime-sulphur, laid out to dry, and were then planted at once. All the plants survived the winter and grew away in a normal manner the following spring, and they compared favourably with the control series.

Another batch of 400 Royal Sovereign plants dipped in a solution of 3 per cent lime-sulphur in February, 1931, gave similar results.

Since it was quite obvious that the plants were not injured by the dipping treatment, at least in the case of Royal Sovereign, a detailed experiment was arranged in the autumn of 1931, to find out what effect dipping the mite infested plants in the lime-sulphur would have upon the mites.

October was selected because it had been ascertained that the egg laying period of the mites had then finished for the year, that adult females only were present on the plants, and under natural conditions the mite population would be at its minimum.

In order to make certain that the mite infestation was fairly uniform, each of the 640 plants was inoculated with five mites, the mites being placed on the crown of the plants by means of a camel hair brush. This operation was done during the third week of October.

The treatments involved were: (1) 3 per cent lime-sulphur; (2) 3 per cent lime-sulphur, Agral I .2 per cent; and (3) Agral I .2 per cent.

All the plants were dipped on 20th October, 1931, and when dry, the plants were planted out the same morning. Unfortunately dry weather conditions followed, and many of the plants dried out before they became established, so that by the following May 50 per cent of the plants were dead. However, it so happened that the mortality was evenly distributed amongst the various treatments, which made it possible to form some idea of their relative effects.

Each plant on the plot, a total of 300, was examined in September, 1932, by means of a small binocular microscope, and every plant was found to be infested with mites. This result was contrary to expectations, because the runners of each block were removed during the summer months, and the plants were not allowed to touch each other, the mites therefore could not pass directly from one plant to another.

Although the inventory showed that the infestation was greater on the water and Agral I treated plots than on those plots treated with lime-sulphur, yet it was not possible to express with exactitude the actual differences in degree of infestation due to the various treatments. As far as one could judge there were certainly fewer mites on all the lime-sulphur plots, but even so, there were far too many mites present to suggest that an adequate control had been obtained. No difference could be observed between the plants dipped in a 3 per cent lime-sulphur, and those dipped in a 3 per cent lime-sulphur with the addition of the Agral I.

From a practical view point it would seem that the lime-sulphur dipping treatment tends to check the mite, but it must not be regarded as a means of entirely eliminating the pest from the plants.

STERILIZING RUNNERS BEFORE PLANTING.

The practice of sterilizing strawberry plants before planting them is by no means a new method of attempting to free them from pests. The writer has been informed that it has been the custom of at least one commercial grower since 1924 to treat strawberry runners in hot water on a commercial scale on a large acreage of plants prior to planting them out.

However, the first publication on the subject appears to be that of Hodson and Beaumont (7) who describe tests they made with the hot water treatment of strawberry plants in 1930. Again, in 1932 Hodson (9) published an article to the effect that the treatment of strawberry plants in hot water at a temperature of 110° F., for a period of twenty minutes, did not affect the plants, but killed the mites and their eggs.*

Doucette and Baker (34) also refer to the hot water treatment of strawberry plants in a report published in the United States of America in 1932. In the course of the investigations, Doucette and Baker found that the plants could be exposed to a temperature of 110° F. in a saturated atmosphere, the treatments being continued for periods of 1½ to 3 hours. As regards injury it was found that some of the plants had their roots affected, but none were killed by the treatments.

The hot water treatment of strawberry plants first attempted in a very small way at East Malling during the Autumn of 1930 was undertaken at the suggestion of Mr. W. E. H. Hodson, of Reading University. This test was a failure as a result of the thermometer being faulty, the plants being overheated.

Further tests have been carried out from August to December, 1932, on a number of Royal Sovereign plants growing in pots, and also upon a large quantity of plants growing in the open. The sterilizing was carried out in a thermostatically controlled bulb-sterilizing apparatus. Between August and October 500 plants have been treated in the bulb apparatus. The plants were sterilized for a period of twenty minutes at a temperature of 110° F. It is too early to state what will happen to the plants next summer, but at the time of writing all the plants are alive, and in a very healthy condition.

* A recent publication by Hodson, describes more fully the Hot Water Treatment of Strawberry Plants. Ref. Hodson (W.E.H.), *Fruitgrower*, 1933, 75 (No. 1938), 2nd Feb., 167-168.

In another experiment which is being carried out at the present time, plants have been treated at temperatures varying from 90° F. to 130° F., the time of sterilizing varying from ten to twenty minutes. It is not yet possible to draw any conclusions from this statistically planned field trial, but there are definite indications that the main treatments have not injured the plants.

In one experiment Hodson (9) found that a temperature of 110° F. destroyed the mites and their eggs if the mite infested plants were submerged in the warm water for a period of twenty minutes. The results obtained by Hodson have been confirmed at East Malling.

Sixty severely mite infested Royal Sovereign strawberry plants growing in pots were sterilized last August, in a bulb sterilizer, for a period of twenty minutes at a temperature of 110° F. The plants have been kept under observation at frequent intervals for five months following the treatment, but living mites have not been observed on any of the plants. The mite eggs still retain their shiny, white transparent appearance after the treatment, but it is evident that they are killed, since none of them have been observed to hatch out.

Another trial has been started to determine whether it will be possible to sterilize at a lower temperature than 110° F., and still kill the mites and their eggs. Plants of the variety Royal Sovereign died almost immediately after treatment at a temperature of 115° F. for a period of twenty minutes. When the exposure of 115° F. was lessened to ten minutes the mortality was not so great, but a number of plants were still affected.

The possibility of sterilizing strawberry plants on a field scale without the use of elaborate apparatus, was tested out in the winter of 1932-33 by a Kentish grower, and it was shown that provided care is taken, and that the sterilizing is done by a competent person, the plants can be sterilized without any risk.

The method used for the field sterilizing was briefly as follows. Five hundred gallons of water contained in a 700 gallon tank, was heated to a temperature of 112° F. by means of a wood fire, the firing being procured from the prunings of a neighbouring apple orchard. The tank was let into the ground up to soil level; and the fire was so arranged that all the tank was heated more or less equally. In a preliminary experiment when the temperature reached 112° F., it was constant in all parts of the tank within ± 1 degree.

Twenty thousand strawberry plants contained in cauliflower bags were placed in the tank when the temperature registered 111° F. As soon as the plants were put in the tank the temperature dropped to 109° F. The fire was stoked up, and after five minutes the temperature read at 110° F. Five readings were made at various positions but the temperature did not vary. At the end of twenty minutes the temperature stood at 110.5° F. The plants were then removed, and taken out of the nets as soon as possible, and were allowed to cool. It will be seen that by this method it was possible to sterilize the plants on a large scale whilst maintaining control of the temperature. It is probable that the success obtained in this large scale dipping trial, was due to the large volume of water used, and to the fact that the tank was embedded in the soil, which would tend to help keep the water at a constant temperature. This field scale hot water treatment has been repeated three times on the same farm, and on each occasion the plants were treated successfully.

It is as yet too early to state how the plants are going to behave in the field, but it can be said that they were in a healthy condition three months after they were planted out.

THE MITE AS A POSSIBLE VECTOR OF THE VIRUS DISEASE KNOWN AS "THE STRAWBERRY YELLOW-EDGE DISEASE."

It has already been stated (page 123) that the mites may cause considerable damage to the plant by direct mite injury alone. It has also been noted that when severely mite infested plants have been entirely freed of the pest, by hot water treatment, or by means of persistent spraying, that a percentage of the plants do not recover, but gradually die out the following season. These are of particular interest, in that they indicate that it would be premature to suggest that direct mite injury alone is always responsible for the failure of the plants. It is possible that these plants were infected with some other disease, and that they would have died anyway whether mites were present or not.

Harris (36) has recently applied methods of grafting for determining the incidence of a suspected virus disease on the variety Royal Sovereign. As a result of further experiments carried out in 1932 (an account of which will shortly be published) he has been able to show that the variety is subject to attack by a disease of this nature, the symptoms of which correspond closely with those of *Strawberry Xanthosis* in America as described by Plakidas, and which he proposes to refer to as the *Strawberry Yellow-Edge Disease*. It is quite possible that the failure of a proportion of the above plants to recover when the mite factor was removed was due to the infection of the plants with this disease.

Unfortunately the masking effect of severe mite infestation made the distinction of the Yellow-Edge disease difficult, if not impossible in such cases. In spite of this the presence of the two diseases on the same plant has been established with such frequency as to suggest that the mite may act as a vector of the virus, and experiments are now in progress to investigate this possibility.

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SUMMARY.

1. Details of the distribution of the mite in this country and continental Europe are given, together with a list of the various host plants of the mite.
2. Notes on the various stages of the life-cycle, which are important from the economic aspect are described in detail; the type of damage caused to established plants and runners is referred to; and a list is given of the commercial varieties subject to attack.
3. Control measures are referred to in some detail, and it is shown that such measures as the spraying of established plants, dusting, dipping of runners before planting and the fumigation of the plants with hydrocyanic acid gas have not proved to be efficient for several reasons.
4. Preliminary trials in which the runners are sterilized in hot water before planting are described, and it is indicated that this method of treating the plants may be of considerable importance in the future.
5. The possible association of the Strawberry Tarsonemid Mite with other strawberry diseases is also referred to briefly.

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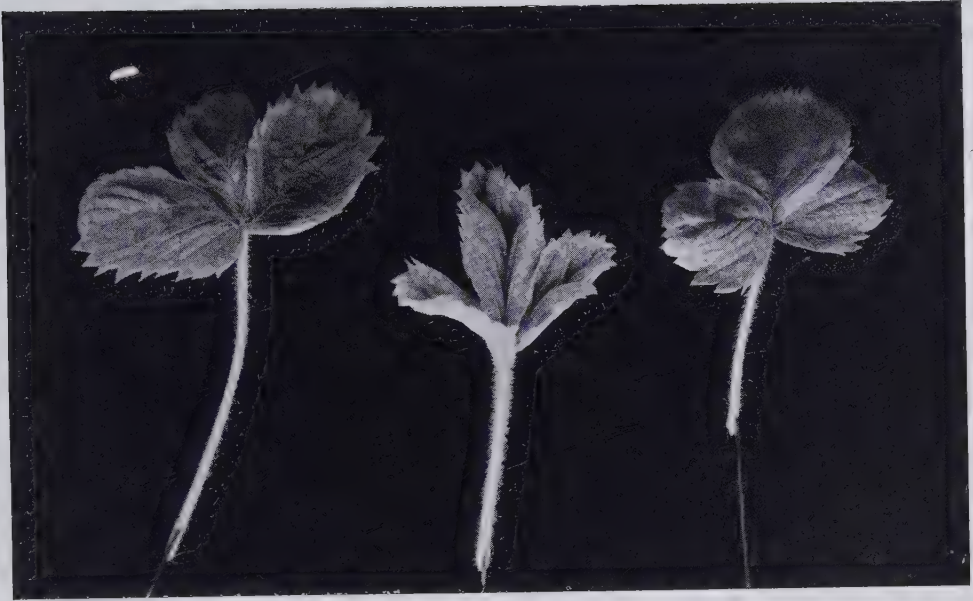


FIG. 1. ROYAL SOVEREIGN. Typical symptoms of mite attack. Note leaf crinkle.



FIG. 2. ROYAL SOVEREIGN. Severe symptoms of mite attack. Note leaf crinkle and distortion. The margins of the leaves are turned upwards and inwards, and are always very brittle. Note also paler edges.



FIG. 3. ROYAL SOVEREIGN. Showing the stage during which the leaflets are attacked and often killed by the mites.



FIG. 4. ROYAL SOVEREIGN. Illustrating the very early natural infection of runners. In this instance the mites migrated along the stolons, and established new colonies at the growing points of the runners.



FIG. 5. ROYAL SOVEREIGN. A one-year-old plant badly malformed by mites. Another instance of natural infection from the parent plant. Note distorted leaflets and weakened crown.

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TWO APPLE CAPSID SPRAYING TRIALS AND SOME NOTES ON SPRAY DAMAGE

By W. STEER

1931 Trial—West Malling.

A grass orchard which had been badly attacked for several seasons by Capsid (*Plesiocoris rugicollis* Fall.) was placed at our disposal by Messrs. E. Taylor & Sons. This was about an acre in extent and composed chiefly of Beauty of Bath and Bramley's Seedling in alternate rows, with odd rows and part rows of other varieties.

The objects of the trial were :

(1) to ascertain whether Apple Capsid can be satisfactorily controlled in this district by means of petroleum or tar-petroleum washes.

(2) to ascertain whether a commercial petroleum wash and a commercial tar distillate "standard" wash could satisfactorily and safely be mixed on the farm and applied as one spray.

(3) to obtain data on spray damage and, as a subsidiary object,

(4) to compare the behaviour of a home mixed tar-petroleum wash with that of a factory mixed proprietary article.

LAYOUT.

The layout was not entirely satisfactory, but was the best which could be designed in view of the shape and constitution of the orchard.

There were three replications of the main treatments (I-III), arranged so that a similar number of Beauty of Bath trees occurred in each plot. The subsidiary treatment (IV) was arranged as nearly as possible in the same manner.

SPRAYS USED.

The treatments were as follows :

- | | | |
|------|---|----------------|
| I. | Proprietary petroleum wash at 10 per cent. | |
| II. | Proprietary petroleum wash $7\frac{1}{2}$ per cent | } Mixture "A." |
| | Proprietary tar distillate wash 6 per cent | |
| III. | Unsprayed controls. | |
| IV. | Proprietary tar-petroleum mixture at 10 per cent—Mixture "B." | |

The petroleum emulsion was a well known preparation which had given good results elsewhere. When used in combination with a tar distillate (treatment II) it was thought advisable to reduce its concentration to $7\frac{1}{2}$ per cent owing to the fear of damage which might otherwise be caused by a spray of excessively high oil content. The tar distillate used in this home-mixed combination wash was a popular commercial article of the "standard" type. On the other hand the tar oils contained in the proprietary tar-petroleum mixture were stated to be high boiling neutral oils.

APPLICATION.

Spraying began on 11th February, and on this date most of the proprietary tar-petroleum wash was applied. Spraying had to be stopped because of wind and was not

resumed till 17th February, owing to adverse weather conditions. The remaining washes were applied on 17th and 19th February.

The sprays all mixed well. Both mixtures, but particularly "A," produced a small amount of scum. In mixing "A" the petroleum preparation was first mixed with a little water and then gradually diluted. The tar wash was diluted separately and the two emulsions were then mixed together in a forty gallon tub.

Both mixtures wetted well and dried rapidly. The petroleum wash wetted less well, was difficult to see on the bark, and dried much more slowly.

SUBSEQUENT OBSERVATIONS.

Both mixtures, but especially "A" killed lichen and burned the grass. The petroleum wash turned the lichen dark green and the grass a deep bronze-green colour.

Mixture "A" somewhat retarded bud break, especially on Beauty of Bath. The buds of this variety were severely damaged; the bloom was sparse and weakly (see plate). Subsequently many of the adventitious buds of the injured trees pushed out and abundant leaf growth resulted. Similar but less serious damage was observed on some of the trees sprayed with Mixture "B."

The sprays all greatly reduced Caterpillar attack. The trees received a spraying of lead arsenate before blossoming owing to the severity of caterpillar on the controls. The spraying, however, was light and no spraying for caterpillar could be carried out subsequently, owing to the fear of leaving an arsenical deposit on the grass. Accordingly the control trees suffered severely.

A good deal of aphid and sucker appeared on control trees and on those trees which were sprayed with the petroleum wash.

RESULTS.

Leaf truss counts were made on the Beauty of Bath trees on 7th and 8th June in order to estimate the incidence of Capsid.

Random samples of 200 trusses per tree were examined—9,400 trusses in all. Table I shows that very little leaf marking had occurred on any of the sprayed plots.

TABLE I.

PER CENT LEAF TRUSSES MARKED. *Beauty of Bath.*

Petroleum.	Mixture A.	Controls.	Mixture B.
3.5	1.5	56.2	4.4

At picking, the crop from each tree was graded into three categories :

- (1) CLEAN—fruit entirely free from Capsid markings.
- (2) SLIGHTLY MARKED—fruit slightly marked but not appreciably mis-shapen as a result of Capsid attack. Capsid markings not exceeding a total area of about $\frac{3}{4}$ inch square on any one apple, i.e. not below the National Mark "C" grade permissible blemish standard.
- (3) BADLY MARKED—fruits badly marked or marked and mis-shapen by Capsid. Markings exceeding a total area of $\frac{3}{4}$ inch square on any one fruit, i.e. below National Mark "C" grade permissible blemish standard.

TABLE II.

ACTUAL NUMBER AND WEIGHT OF APPLES PICKED.

	Clean.		Slightly marked.		Badly marked.		Total.	
	No.	lbs.	No.	lbs.	No.	lbs.	No.	lbs.
BEAUTY OF BATH :								
Petroleum	3437	422.2	187	20.1	179	17.3	3803	459.6
Mixture "A"	1342	189.5	110	14.1	58	6.6	1510	210.2
Controls	316	32.7	39	3.8	318	17.6	673	54.1
Mixture "B"	2072	274.8	155	19.7	177	17.6	2404	312.1
BRAMLEY'S SEEDLING :								
Petroleum	3026	612.0	36	6.6	156	20.0	3218	640.4
Mixture "A"	1099	283.3	11	2.0	71	12.8	1181	298.1
Controls	918	231.6	109	24.9	580	95.9	1607	352.4
Mixture "B"	1257	254.4	38	8.0	207	30.1	1502	292.5

For the purposes of statistical analysis the numbers of slightly and badly marked apples were added together and treated as one grade (Tables III and IV).

TABLE III.*

Beauty of Bath. PER CENT MARKED APPLES.

	I. Petroleum.	II. Mixture "A."	III. Controls.	IV. Mixture "B."	General Mean.	Standard Error.	Significant Difference.
No. of Trees ..	12	11	12	11	—	—	—
Per cent marked Apples per Tree	13.3	10.1	73.0	20.5	29.2	6.15	17.4

TABLE IV.*

Bramley's Seedling. PER CENT MARKED APPLES.

	I. Petroleum.	II. Mixture "A."	III. Controls.	IV. Mixture "B."
No. of Trees ..	13	13	7	13
Per cent marked per Tree ..	4.7	4.7	54.0	12.9
Standard error ..	3.9	3.9	5.3	3.9

Between any two sprayed treatments a difference of 11.0 is significant.

Between any sprayed treatment and the controls a difference of 13.1 is significant.

* Tables III and IV. Where the number of observations (trees) was the same or very nearly the same in each treatment (e.g. Beauty of Bath, Table III) a common standard error and, consequently, a common significant difference could be calculated.

In dealing with the Bramleys the number of trees of treatment III (Control) which could be taken into consideration was much lower than that of any other treatment. Thus a separate standard error had to be worked out for each mean and, although the significant difference is the same in comparing any pair of sprayed treatments, in any comparison involving the controls the significant difference is necessarily higher. These standard errors are based on a common Standard Deviation of 14.0.

It is evident that there were no significant differences between any of the sprayed treatments, each of which gave a good control of Capsid.

Observations in the field and the data contained in Table II suggest that Mixture "A," and possibly Mixture "B" also, reduced the yield. It was not possible to confirm this by a statistical examination of the records, since the variation in the crop per tree was very high.

The Beauty of Bath apples from the control plots were smaller in each grade than those from any sprayed series. In the marked grades this could be attributed to Capsid damage, but in the clean grade the smaller average size might be due to other insect damage, or, indirectly, to damaged foliage.

The apples from the plots sprayed with either of the mixtures were larger in each grade than those from control or from petroleum sprayed plots.

In the case of the Bramleys these differences in average size were neither so obvious nor so consistent; Capsid did not markedly reduce the size of the fruit.

1932 Trial—West Peckham.

It was felt that there was little to be gained by carrying out trials (such as the 1931 trial) with proprietary products of unknown composition. The help and collaboration of the chemical and entomological departments of Wye College were therefore enlisted and a trial was planned on lines parallel with a series of trials carried out by Wye College using oils of known characteristics.

MATERIAL.

About two acres of Lord Derby half standard apples, growing at West Peckham, Kent were placed at our disposal by Mr. Bernard Champion. The piece comprised 240 trees, of an average height of about twenty feet and about twenty-two years old.

LAYOUT.

The layout provided for four replications of five treatments and was arranged to allow of statistical analyses of the results.

SPRAYS USED.

The five treatments were:

A	{	Petroleum oil	..	..	6 per cent.*
		Oleic acid	..	..	1 per cent.
		Caustic soda	..	..	0.15 per cent.
B	{	Petroleum oil	..	..	6 per cent.
		Strained anthracene oil	..	..	4 per cent.
		Oleic acid	..	..	1 per cent.
		Caustic soda	..	..	0.15 per cent.
C	{	Petroleum oil	..	..	6 per cent.
		Strained anthracene oil	..	..	4 per cent.
		Bordeaux Mixture	..	..	4 : 6 : 100
D	{	Strained anthracene oil	..	..	4 per cent.
		Oleic acid	..	..	1 per cent.
		Caustic soda	..	..	0.15 per cent.
E		Unsprayed "controls".			

* It should be remembered that the concentrations of these sprays refer to their actual oil content and not, as in the 1931 trial, to the content of emulsion. Thus the 6 per cent petroleum oil spray described above would contain as much oil as $7\frac{1}{2}$ per cent of an emulsion of 80 per cent oil content.

The petroleum oil was a light lubricating oil costing 1s. a gallon (Shell J.D. 2) and the tar oil a strained anthracene oil costing 9d. a gallon. Their characteristics, as determined by Mr. H. Martin were as follows :

	<i>Petroleum oil.</i>	<i>Strained Anthracene oil.</i>
Neutral oil	—	88.9
Acids	—	4.9
Bases	—	5.7
Sp. Gr. (60° F.)	0.899	1.111
Viscosity (Redwood 1 @ 70° F.) ..	167"	—
Boiling Range :		
1st drop	335° C.	(water)
10% by vol.	347	267° C.
20% " "	354	292
30% " "	362	313
40% " "	369	327
50% " "	375	338
60% " "	385	351
70% " "	394	363
80% " "	—	379
Unsulphonated residue % by vol.	68.2	—
Methyl sulphate % by vol. insol.	100.0	—

All but one of the sprays were emulsified by the oleic-acid-caustic-soda method described by Martin.* The exception (treatment C) was emulsified by means of Bordeaux mixture 4 : 6 : 100 and was included in this trial at Mr. Martin's suggestion.

APPLICATION.

The spraying was done on 16th and 17th February with a 7 h.p. three-throw-pump machine. Four nozzles were supplied at a pressure of 300 lbs. per square inch.

The weather was fine and favourable for spraying operations. A slight N.E. wind caused some spray drift, but this was insufficient to affect those trees ultimately selected for recording purposes.

The oils in treatments "A," "B" and "D" were mixed with the oleic acid and then poured into and mixed with the water in the spray tank, to which caustic soda (1½ lbs. per 100 gallons) had already been added.

A similar procedure was adopted in mixing "C" except that copper sulphate solution was substituted for the oleic acid and hydrated lime for the caustic soda.

No trouble was experienced in mixing any of the sprays save the Bordeaux-oil emulsion (C). This had to be pumped back into the tank till emulsification was completed. A great deal of scum was produced and the wash went on the trees as a greenish yellow mess which dried very black. Some little time after application the drips which hung on the twigs appeared as clear water, suggesting that the emulsion "broke" quickly.

In application the tar wash (D) differed in no way from the usual "standard" tar washes. The oleine emulsified mixture (B) went on satisfactorily and dried black. The petroleum oil emulsion (A) possessed the common faults of similar washes in that it wetted less well than a tar or tar-petroleum wash and was difficult to see on the bark. These faults resulted in an unduly large consumption of spray.

* *Journ. South Eastern Agric. Coll., Wye, 1931, p. 181.*

SPRAY DAMAGE.

At the end of April all the sprays appeared to have slightly retarded the buds, the petroleum wash possibly least of all. Dead and moribund buds were plentiful and fell off easily but, since such buds could be found on the unsprayed trees also, it was impossible at this stage to ascertain whether spray damage had occurred.

It became more and more evident as time went on that the mixture had caused retardation and serious bud injury. Thus in the middle of May the trees sprayed with either of the mixtures wore a bare, almost wintry look—very few trusses were out and a few wood buds were just breaking, but most of the buds had not begun to open. Practically every bud on a Bramley in a plot sprayed with the Bordeaux emulsified wash (C) was killed. The trees sprayed with this looked even worse than those sprayed with the other mixture, since the bark was covered with a thick, brown, greasy deposit which served to accentuate the bareness of the wood.

Yet, by the last week in May, even the most severely injured trees bore a very fair show of blossom and the adventitious buds were fast pushing out. Close inspection showed that the buds which had not yet moved (no small number) were killed, and these dropped off at a touch.

Severe loss of crop would undoubtedly have occurred in a good cropping season. The yield from this plantation, however, was very poor in 1932 and analyses of the crop records (Tables VI and VII) failed to show significant differences in yield between any of the treatments.

It is interesting to note that the plot where the damage was worst consisted of the tallest trees. In an attempt to cover the topmost twigs the other parts of the trees were oversprayed, and since the wash was the quick breaking Bordeaux emulsified mixture, a large quantity of oils no doubt, was deposited.

OTHER OBSERVATIONS.

The size of the trees did not permit of leaf truss counts, but frequent inspection showed that Capsid occurred on all the unsprayed trees and on those sprayed with the tar wash. It was evident that the attack was neither as severe nor as uniform as had been expected.

All the sprays gave a good control of caterpillar, and all but the petroleum wash controlled aphid and apple sucker.

RESULTS.

The crop from three trees in the centre of each plot was picked and graded into clean, slightly marked and badly marked categories, using the same standards as in the 1931 trial. The number and weight of apples in these categories were recorded for each tree.

TABLE V.

LORD DERBY. PER CENT FRUITS MARKED. MEAN PER PLOT OF THREE TREES.

A.	B.	C.	D.	E.	General Mean.	Standard Error.	Significant Difference.
Petroleum.	Tar-Petroleum.	Tar-Petroleum-Bordeaux.	Tar.	Controls.			
1.7	0.2	1.0	18.1	26.7	9.56	4.0	12.4

There is no significant difference (Table V) between any of the sprays which contained 6 per cent petroleum oil (A, B, C). Each gave a good control and the inclusion of 4 per cent tar oil (B and C) did not affect the results.

The substitution of Bordeaux mixture for oleic acid and caustic soda as an emulsifier did not affect the results.

Four per cent tar oil alone (D) did not reduce the attack. The average infestation on unsprayed trees (E) was somewhat higher (though not significantly so) than on trees sprayed with 4 per cent tar oil (D), but this was entirely due to a high figure (44.3 per cent) obtained on one plot.

TABLE VI.

NUMBER AND WEIGHT OF APPLES—MEAN PER PLOT OF THREE TREES (TO NEAREST WHOLE NUMBER).

	A.	B.	C.	D.	E.			
	Petroleum.	Tar-Petroleum.	Tar-Petroleum plus Bordeaux.	Tar.	Controls.	General Mean.	Standard Error.	Significant Difference.
No. per Plot ..	559	246	356	480	548	437.7	107.7	331.9
Per cent of General Mean ..	128	56	81	110	125	100	25	76
lbs. per Plot ..	191	90	125	148	170	144.8	35.6	109.8
Per cent of General Mean ..	132	62	86	102	118	100	25	76

The analyses (Table VI) reveal no significant difference in yield between any pair of treatments and show also that the variation was very high. Nevertheless, in view of observations made in the field, it can safely be said that each of the mixtures ("B" and "C") reduced the yield.

Conclusions.

The small size of the crop detracted from the value of both the experiments and limits the conclusions which may validly be drawn from the data.

It would seem that the Apple Capsid can be satisfactorily controlled in this area by means of either petroleum oils or tar-petroleum mixtures. The latter, however, are liable to cause serious bud injury and consequent loss of crop, at any rate if applied in the middle of February.

Good control was obtained with sprays containing 6 per cent of a light lubricating oil (equivalent to $7\frac{1}{2}$ per cent of an emulsion with an 80 per cent oil content) and the control action was not impaired by the addition of 4 per cent of a strained anthracene oil.

Although neither 6 per cent petroleum nor 4 per cent strained anthracene oil alone caused perceptible damage, a mixture of the two caused very severe bud injury.

The experience gained in the 1931 trial suggests that it is unwise for growers to mix a petroleum emulsion with an ordinary tar distillate wash.

Perhaps the most important conclusion which can be drawn is the paramount necessity in such trials as these for a proper layout, comprising an adequate number of replications and suitable randomization of the treatments. The uneven distribution of Capsid in the orchard calls for a distribution of the plots in such a way that each different treatment has an equal chance of experiencing any differences which may occur in the intensity of Capsid attack. Moreover, uniformity of material (e.g. as regards cropping) is scarcely ever to be found in commercial plantations, a fact which renders adequate replication and distribution of the plots all the more necessary.

Spray Damage to Undercrops.

In order to obtain information on the effect of Winter Capsid washing on undercrops the sprays used in the above trials were applied also to strawberries, gooseberries and red and black currants.

The strawberries were divided into units of ten yards of row, whilst the units used for the bush fruits were from one to four bushes. The treatments were randomized and arranged in duplicate.

The sprays were applied with a knapsack machine, and, since it was impossible to imitate spray drift in a satisfactory manner, the bushes were given sufficient spray to ensure a good cover. The strawberries were sprayed from above and well wetted.

1931 TEST.

The same sprays were used for this as for the 1931 Capsid spraying trial and at the same strengths. In addition a proprietary tar distillate wash of the "standard" type was used at 10 per cent concentration.

The dates of application were :

	<i>Red currants</i> (<i>Abundance</i>).	<i>Black currants</i> (<i>Davidsons Eight</i>).	<i>Gooseberries</i> (<i>Whitesmith</i>).	<i>Strawberries</i> (<i>R. Sov.</i>).
Petroleum	5-6 March	5-6 March	12 March	12 March
Mixture "A"	5-6 March	5-6 March	6 March	6 March
Controls	—	—	—	—
Mixture "B"	5-6 March	5-6 March	12 March	12 March
Tar distillate	5-6 March	5-6 March	13 March	13 March

Cold weather delayed some of the applications by about a week. The strawberries were not sprayed till growth started and then a further delay was caused by the weather.

In brief all the sprays scorched the leaves of *strawberries* (Royal Sovereign), but the petroleum wash least severely of any. The damaged plants were severely checked, and produced stunted, deformed leaves and some deformed trusses. Some plants were killed. The petroleum sprayed plants showed the greatest tendency to recover.

On *gooseberries* (Whitesmith) the sprays containing tar oils caused some retardation and stunting of the early leaf growth. Mixture "A" and the tar distillate wash each caused an almost total loss of crop. Mixture "B" (in which the tar oils were stated to be of the "high boiling neutral" type) did not appreciably affect the crop. The petroleum oil had no deleterious effects on either leaf growth or fruit development.

No damage was observed on red currants (*Abundance*) or on black currants (*Davidsons Eight* and *Baldwin*) with any of the sprays. It is interesting to note here that *Davidsons Eight* is a variety which frequently suffers spray injury from lime-sulphur in 12 applied early in April.

1932 TEST.

The same sprays were used in this as in the 1932 Capsid field spraying trial, and at the same concentrations. The layout of the tests and the manner of application differed in no way from the previous year's tests on undercrop fruits.

The dates of application were :

Petroleum oil	..	..	..	26th February.
Tar-petroleum (oleic)	..	..	..	26th February.
Tar-petroleum (Bordeaux)	..	..	..	27th February.
Tar oil	..	..	..	2nd March.
Controls	..	..	..	Unsprayed.

The application of the tar was delayed a few days by inclement weather.

Each of the sprays caused damage to *strawberries* (Royal Sovereign). They browned the foliage and retarded the new growths. The petroleum was least severe of all in its action whilst the sprays containing tar oil were very severe indeed. Besides scorching the plants and retarding the growth the latter killed many plants and reduced the amount of bloom.

On *gooseberries* (Keepsake) the results were not entirely conclusive, but the sprays containing the tar oil slightly retarded leaf development.

None of the sprays damaged *red currants* (Fertility and Abundance) or *black currants* (Baldwin).

ACKNOWLEDGMENTS.

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Thanks are also due to Mr. T. N. Hoblyn for his valued assistance in planning the layout of both trials and to him and to Miss J. Edgar for analyses of the figures.

SUMMARY.

(1) Two field spraying trials carried out against Apple Capsid (*Plesiocoris rugicollis* Fall.) on Beauty of Bath, Bramley's Seedling and Lord Derby are described.

(2) Good control was obtained with petroleum oil emulsions and with tar-petroleum mixtures, using in the one case proprietary washes and in the other oils of known characteristics, emulsified in an uniform manner.

(3) Tar-petroleum mixtures, although effective against Capsid, caused serious bud injury.

(4) The sprays used in the two trials were applied also to various small fruits commonly grown as undercrops and a summary is given of observations made on their effect on these fruits.



Typical Beauty of Bath twigs from unsprayed "Control" trees and (below) from trees sprayed with mixture "A."

Section IV

BULLETINS FOR FRUITGROWERS

POMOLOGY

THE REVIVAL OF SMALL-FRUIT GROWING IN THE LIGHT OF PRESENT DAY KNOWLEDGE*

BY N. B. BAGENAL, R. V. HARRIS, A. M. MASSEE AND A. C. PAINTER

INTRODUCTION.

Those who have followed the fortunes of the exhibitors in the Small Fruit Classes in the Kent Cherry and Soft Fruit Show during the last seven years will have observed that the most consistent prize-winners have been those growers who have paid special attention to the culture of one or more kinds of fruit, particularly in the case of gooseberries, red currants and strawberries. And our experience here also, from the days when the first Black Currant Trials were planted some twenty years ago, all tend to show that in the culture of small fruits no less than in the growing of apples, success depends upon the close and continued attention to detail, in planning, planting and subsequent cultivations. At the present time when there is every indication that there is to be a big increase in the acreage of small fruits during the next few years, no apology is needed for drawing the attention of fruitgrowers to a few leading points in this connection.

PLANNING AND PLANTING.

In the first place we would plead for a careful reconnaissance of the site and soil, bearing in mind the special requirements of each particular fruit. Very often the past history of some field may reveal the fact that while it is highly suitable for black currants, it may be wholly unsuitable for strawberries or for gooseberries. A field that may be well protected from the south-west gales may yet lie open to the east winds, and, if these blow during blossom time, the pollinating insects are apt to give that field a miss. Then again, the young shoots of some varieties of gooseberry, such as Lancer, and of red currants, such as Fay's Prolific, have the bad habit of breaking out during the growing season, and this habit is so much accentuated in windy places that it sometimes proves impossible to establish a plantation. Or, again, a field that has all that is required in the way of soil and freedom from frost may be too far away from the water supply, and this would mean that spraying would be altogether too expensive for economical management. Above all, let the reconnaissance be carried out at such times as will allow the land to be seen at its worst as well as at its best. It is of the utmost importance to allow plenty of time before planting to ensure getting hold of really good material for planting.

This brings us to the second point of fundamental importance, namely, what to plant. And here it should hardly be necessary to point out that not all the varieties which win first prizes at the Cherry and Soft Fruit Show are necessarily those which

* Reprinted from the Catalogue of the Kent Cherry and Soft Fruit Show, July, 1932.

must at all costs be planted commercially. For instance, the Leveller gooseberry, whilst its fruit qualities are such as to secure it a place in every prize list, is a variety which appears to have certain very marked preferences particularly in regard to soil and management and is by no means a "good doer" under our conditions. Pyne's Royal raspberry again, another regular prize-winner at shows, is a shy cane-maker and there are very few places where it can now be planted with any real certainty of success. On the other hand, Baldwin black currant, which, owing to its late season, seldom, if ever, appears in the show prize lists, is on certain loamy soils and under certain cultural treatment a better cropper than any other commercial variety.

If small fruits are being planted solely or mainly for canning, a certain amount of information is available as to the varieties most favoured by the canners,* but here again it should be remembered that however good the fruit quality may be for any particular purpose, the first essential from the grower's point of view is that the variety should grow and crop well under his conditions, and should answer the purpose for which it is planted. Thus it would be no use planting a jam raspberry such as Baumforth A for punnet work, nor, if one were going to take out a contract with canners, would there be any point in planting a variety like Bath's Perfection. So that, while it is possible with most of the small fruits to make up a "short list" of from three to six varieties which are obviously desirable from a market point of view, it is not wise to make a final decision without a further reconnaissance of the surrounding district to see which of these varieties are doing best under similar conditions.

In the case of black currants and gooseberries and, to a lesser extent, red currants also, there is no doubt that a succession of varieties is called for not only for convenience of picking but because, owing to the exigencies of climate and the vagaries of the market, it may be found that early varieties will pay best one year and late varieties the next.

Having decided what to plant, the next important consideration is the method of planting. With regard to this, the arguments from the scientific point of view are very much in favour of keeping small fruits strictly apart from top fruits, and, if this is not possible, of interplanting only with those kinds and varieties of fruits which are known to require the same kind of manurial and cultural treatment as the top fruits under which they are to be planted.

Experiments have shown that in the successful management of a fruit plantation, much depends upon giving the trees and bushes as much of each kind of fertilizer as they require. The work of Dr. Wallace at Long Ashton has familiarized growers with the importance played by potash in the proper balancing of a fruit tree's rations and has shown further that different fruits require different proportions of these various fertilizers and that when they receive an "unbalanced ration" the results are often unsatisfactory.

The manurial factor therefore is one which must be taken into consideration when planting small fruits. When planting up a nitrogenous hop garden for instance, preference should be given to the kinds of fruits such as black currants, loganberries and blackberries which are known to be lovers of nitrogen, whilst fruits such as gooseberries, red currants and strawberries which are known to require a certain potash balance in their diet are best reserved for lands which are not too highly charged with nitrogen or for soils which have already been receiving a balanced dressing.

Where it is found essential to plant small fruits in the same field as top fruits, we would urge that, so far as possible, the same principle should be adopted. Plums and Morello cherries so far as our present knowledge goes are, on the whole, more suitable companions for black currants, loganberries and blackberries than for gooseberries,

* Canners' Bulletin No. 3 : Varieties of Fruits Suitable for Canning. By F. Hirst and W. B. Adam.

red currants or strawberries. When it comes to the point of purchasing material for planting, we would urge the fundamental importance of every grower insisting upon seeing the bushes or canes which he intends to buy actually growing in the field in the Summer previous to the season in which he intends planting. And, since growers themselves are the main commercial source of supply for small fruits, we would enter a special plea to all growers who sell cuttings, bushes, canes or runners, to set their house in order now before the general scramble for supplies of material becomes too acute.

Nothing but really healthy material, true to name and rigidly rogued is good enough for planting, and once the demand for this becomes sufficiently insistent, the supply will be forthcoming.

Knowing the supreme importance of this point, we would urge all growers, both buyers and sellers of small fruit cuttings, bushes, canes or runners to take full advantage of the admirable Certification Schemes instituted some years ago by the Ministry of Agriculture as a result of the work of the Research Stations of this country.

There has been too much planting in the past of mis-named, diseased and useless rogue varieties of all small fruits and, as every grower knows, no amount of good advice from the pathologist will serve to make a paying proposition out of a badly planned and badly planted piece of fruit.

AWARENESS OF DISEASE.

When planning a new plantation of soft fruits, it is only too easy to postpone the consideration of the question of disease control until "the disease actually arrives". To do so, however, is certain sooner or later to involve the grower in unnecessary expense, and, even if the plantation receives optimum treatment in cultivation and manuring, its cropping will most likely be handicapped from the start both in quantity and in quality.

(a) *Disease resistance must be considered when selecting the varieties to be planted.*

The future efficiency of a raspberry plantation for example depends to a considerable extent on selecting varieties which under the grower's local conditions combine good fruit quality and high cropping capacity, with high resistance to disease, in particular to *Mosaic disease*. Thus, some varieties of raspberry which are profitably grown in Northern districts cannot be grown successfully in Kent, largely because in this area they become extremely susceptible to Mosaic disease. The same principle applies to other small fruits, particularly with regard to resistance to diseases belonging to the same group as raspberry mosaic (virus diseases), i.e. *Black currant Reversion*, *Strawberry Yellow-Edge*, and probably a disease popularly known as *Blackberry and Loganberry "Reversion"*. But, even so, the range of good varieties which show the maximum resistance to such diseases is not very extensive and some of the most popular varieties, e.g. the Lloyd George raspberry, are moderately susceptible to virus disease. The planting of such varieties brings us to the second maxim to be observed:—

(b) *Plant up with cuttings, bushes, canes or runners which are Virus-free.*

In the early years of a particular variety, it will be easy to obtain sets of plants with a low percentage of virus infection, but in the normal course of events, as a variety gets older it becomes increasingly difficult to do so. Thus, in the case of the Lloyd George raspberry, certain growers are already finding it worth while to lay down cane nurseries (planted in the first instance with virus-free cane raised at the Research Station) designed solely for producing reliable virus-free cane in quantity for planting up their new

plantations.* The same principle will certainly have to be applied with strawberries, loganberries and blackberries in relation to the diseases already mentioned, the seriousness of which has only recently become apparent.

Finally, having insured an optimum start for the new plantation by obtaining a stock of virus-free plants, we arrive at the third principle to be observed:—

(c) *The lay-out of the Plantation must be planned to aid the control of diseases which may subsequently appear.*

For instance, when planting strawberries, the consideration that it will probably be necessary to dust them with sulphur against "Mildew" (just before the flowering period) will ensure that the rows are sufficiently spaced to allow the passage of some form of dusting machine.

Again, when deciding on the training method of loganberries and blackberries to be employed, the probable incidence of the important fungus diseases, *Cane Spot*, *Spur Blight* and *Purple Blotch* should be borne in mind. In the case of all these diseases, the new canes are infected by spores dispersed from the fruiting canes, mainly from fruiting canes in their immediate neighbourhood. Evidence has recently been forthcoming that a considerable degree of control of these diseases can be achieved (quite apart from spraying) by adopting a method of training which ensures that the new canes, as they grow, will be kept as far removed from the fruiting canes as possible instead of being laid immediately underneath them.

Lastly, the possibility that, in spite of these precautions, it may be necessary to spray the stools against these diseases should be borne in mind and the method of training adopted should be such as to facilitate the efficient covering of the new cane and fruiting cane with a spray fluid before the flowering period and (if necessary) the new cane during the flowering period.

AWARENESS OF INSECT PESTS.

When the planting of soft fruits is contemplated, it is just as essential to study the problem from the insect point of view as it is to take account into the cultural problems and many other aspects which have to be borne in mind.

The first essential is to select healthy plants, not merely healthy from the cultural aspect, but plants which are vigorous and free from pests. For example, strawberry runners should be obtained from plants free of the Strawberry Red Spider and the Strawberry Tarsonemid Mite. Black currant cuttings or bushes must be selected from plants free from Big-bud and Reversion. The same story applies to raspberries, gooseberries and other soft fruits. Half the battle is won if the plants are free from pests at the time of planting.

Now, this is not always possible, but precautions can be taken to insure against outbreaks of many of the numerous insects and mites which attack soft fruits. For instance, strawberry plants should be dipped in a 3 per cent lime-sulphur wash before planting if mites are suspected of being present. Black currants, gooseberries and other soft fruits (not including the strawberry) should be dipped in a 5 per cent tar-distillate. This simple operation saves a good deal of time and money, and also encourages the plants to grow away vigorously during their first season, and, incidentally, spraying against aphids the following spring is very largely eliminated.

Another point in favour of dipping the plants before the actual planting is done is worthy of mention. If the spraying operation is left until some time after planting,

* Notes on the planting and maintenance of cane-nurseries will be supplied on application to the Research Station.

the ground is very often in a very "stodgy" condition, and by the time the spraying gang has finished its work, the ground is trodden down firmly and remains unkindly all the winter.

Another point which must be considered is the selection of varieties. Care must be taken not to plant "sulphur-shy" varieties of gooseberries (i.e. Leveller) alongside "sulphur-resistant" sorts, or complications will ensue when spraying operations are being carried out. It will mean going over the same ground twice, spraying one variety with one type of spray and the other sort with another kind of wash. Exactly the same applies to black currants. If "sulphur-shy" varieties of the Edina group are selected, they should be planted separately, and not mixed along with "sulphur-resistant" varieties such as Baldwin and Boskoop Giant.

When the grower says "I am going to plant strawberries in this field," he does not always make quite certain that the land is suitable, and seldom takes into consideration what kind of crop has been growing there before. For example, it is often useless planting strawberries in a field which was previously grassed down, on account of the presence of wire-worms, leather-jackets or cockchafer grubs.

Again, strawberries planted on old hop land are frequently destroyed by the larvae of the Swift Moth or "Otter". Although this insect attacks the roots of the hop it does very little harm, but directly the hops are grubbed and strawberries are planted in their place, then the larvae get to work and destroy them before they become established. Many other examples could be quoted if space permitted. Surely it is far better to survey the land before planting to determine whether these noxious insects are present or not!

Finally, when considering the question of planting at the most economical distance between the rows, to allow for cultural operations, it should be borne in mind that spraying operations may be necessary at some future date, and this must be considered. Take strawberries for example. They should be planted in such a manner that a spraying machine or an adapted hop washer can be drawn along the rows without damaging the plants. It is now considered just as necessary to spray strawberries at least twice a year to control mites and mildew, as it is to carry out routine spraying in the orchard.

The availability of water is also a very important point. Do not plant soft fruits miles away from anywhere and then suddenly find that it is impossible to obtain sufficient water when spraying operations are deemed necessary.

THE NEW OUTLOOK IN MARKETING.

Increasing competition, the relatively high cost of production, and the low prices ruling for poor grade fruit have all tended to bring about a revolution in the various aspects of marketing.

The time is past when a grower could pick his crops and send them haphazard to the markets and still get a fair return. Now he cannot afford to neglect any means by which an increased return may be obtained. In this connection there are various factors it is well for him to bear in mind:—

1. The need for studying the requirements of the market to which he consigns his fruit, whether it be the fresh fruit market, the cannery or the jam factory. In this, he may well enlist the assistance of his salesman.
2. The necessity for careful picking and handling of his crops. Much of the damage so often noticeable is due to lack of care in handling or to the fact that the fruit is allowed to become over-ripe before being picked.

3. *Grading.* This is another matter to which careful attention must be paid. Graded fruit almost invariably finds a readier sale in the markets than ungraded produce, especially in time of glut.

4. *Presentation of the Fruit.* The psychological effect of a pleasing presentation on a would-be purchaser is well known. The chip basket and other similar non-returnable packages which also enable the fruit to pass straight from grower to consumer without being rehandled, go a long way towards meeting this need, and are becoming increasingly popular. The ordinary returnable empty, apart from other considerations, is, as a rule, too large, and if the fruit is at all on the ripe side is liable to damage the contents.

All these points and others are fully dealt with in the Ministry of Agriculture reports on "The Preparation of Fruit for Market" (Economic Series, Nos. 21 and 24), and from these much valuable information can be obtained.

SUMMARY.

A brief survey of some of the most important factors in the production of soft fruit on an economic basis. Reference is made to the application of latest research findings to the selection of site, planning and planting, selection of suitable varieties, and the manurial programme. The importance of the consideration of disease in the planning and conduct of soft fruit plantations is discussed with regard to the choice of varieties, the procuring of healthy material, and layout of plantations in relation to disease control. Emphasis is laid on the need for careful picking, grading, and selection of package to suit the requirements of the particular market to which the fruit is consigned.

MYCOLOGY

APPLES SHOULD BE PICKED WITH THEIR STALKS*

By H. WORMALD

IN 1927 the writer described† an instance of Brown Rot of Apples where infection had started at the wound left by pulling the fruit away from the stalk instead of picking it with the stalk attached. The rot was observed as the apples were being graded and packed two or three days after they had been picked. The symptom of infection was a brown area about an inch in diameter around the stalk end. The diseased apples were kept under observation ; in a few days they had become completely brown, and numerous fructifications of the brown rot fungus *Sclerotinia (Monilia) fructigena* appeared on the surface. It was concluded therefore that the apples had become infected by the brown rot fungus, at, or soon after the time of picking and that the fungus had got in through the wound left when the fruit was pulled away from the stalk.

In the article describing that type of infection it was stated, " Had these apples been sent to market, when they already showed evidence of infection, they would have been unsaleable soon after their arrival. However carefully apples are picked a certain number will be pulled away with damaged strigs. During grading these should be set aside with the bruised fruit for immediate use. Such fruit should not be stored."

In that particular case the fruit was not marketed for several days after picking so that the infection had had time to become manifest. Had the apples been sent to market immediately after they were picked (on the same or following day) the infection would not have been noticed until after the fruit had arrived at the market. However until the present year the writer had not heard of losses in marketed fruit due to brown rot infection as a result of picking the fruit without stalks.

On 12th August a Sussex fruitgrower brought to the East Malling Research Station a number of apples showing a brown rot at the stalk end, the discoloration extending about half way towards the calyx end. All the apples showing this type of injury were without stalks.

The grower said that the fruit had been picked on the 8th, 9th and 10th and sent to market by road on the evening of the 10th, when they were apparently quite sound. On the afternoon of the 11th the grower saw the fruit at the market and found many of them rotting. He thereupon collected some of these and sought advice as to the cause of the damage and means of prevention. The varieties involved were Early Victoria, Grenadier and Gladstone. The rot was not observed on Beauty of Bath.

When examined on the 12th the infected areas bore no fungal fructifications, but from the nature of the damage it was suspected, from analogy with the observations made in 1927 that the cause of the rot was *Sclerotinia fructigena*. For confirmation however particles of the infected pulp were removed from the edge of the infected area (taking care to avoid contamination from outside) on two of the apples. The apples were then left on a bench in the laboratory. By the next day two of them had produced a few *Monilia* fructifications, and by 16th August (about a week after they were picked

* Reprinted from the *Gardeners' Chronicle* (10 Sept., 1932, p. 200) by permission of the Editor.

† *Journ. Ministry of Agric.*, XXXIV, 1927, pp. 552-554.

from the trees) most of the infected apples were brown all over, the rest having a little of the surface still sound at the calyx end, and all bore numerous fructifications typical of the common brown rot fungus. Moreover the cultures prepared from the rotting tissues eventually produced pure cultures of the same fungus.

It was evident therefore that this was another case of brown rot infection following careless picking and the grower stated that he had noticed that one of his inexperienced farm hands had picked many fruit without stalks. He admitted that he thought this a bad practice but did not realize why it was so important to avoid it.

Sclerotinia fructigena, as is well known, readily infects apples through any wound in the skin, and insect punctures are frequent ports of entry for the fungus. Such injuries cannot usually be avoided but damage due to lack of care in picking can to a large extent be obviated. Careless picking as here shown may cause the grower to suffer financial loss not only because of the actual depreciation of the fruit due to rot, but also from the cost of packing and transport of an unsaleable product.

SUMMARY.

A rapid development of brown rot of apples after arrival at the market is described. The infection arose at the wounds left by picking the fruit away from the stalk instead of *with* the stalk.

THE COMMERCIAL CONTROL OF RASPBERRY-MOSAIC DISEASE

BY R. V. HARRIS AND N. H. GRUBB

I. INTRODUCTION.

An investigation of raspberry-mosaic disease was started at East Malling in 1921 as a part of a general study of the causes of the degeneration and failure of certain widely grown and popular raspberry varieties such, for example, as *Superlative*, *Baths Perfection* and, latterly, *Lloyd George*. Preliminary experiments indicated that the well-known mottling of the foliage of certain stools is a symptom of their infection by a virus disease (i.e. a disease of the same class as "Potato Leaf-roll") and that once the infection of a stool of a susceptible variety takes place, the whole stool is permeated by the virus and never recovers but commences to lose its vitality, and every cane derived from that stool will give rise to another infected stool. It is clear, therefore, that unless some system exists for eliminating infected canes from the source of supply, every successive batch of canes planted by growers will contain an increased proportion of infected canes until a point is reached at which the whole stock of cane of a given susceptible variety is infected, when it will only be a matter of time before that variety becomes commercially useless. From 1924 onwards, an intensive study of the disease was carried out in the laboratory and by means of field observation and experiments. On the basis of the considerable body of data obtained (a detailed account of which is being prepared for publication) it was concluded:

(1) that the direct control of the disease by the removal or "roguing" of infected stools in *established fruiting plantations* was impracticable, the labour involved being out of proportion to the *immediate* benefit obtained, and

(2) that a practical scheme of control should aim at providing the grower at any stage in the life of a variety with virus-free supplies of cane for planting up his fruiting plantation.

In view of the former conclusion, and to achieve the latter object, it was necessary to cease to regard the commercial plantation as both a source of fruit and of canes. In 1927 experimental "cane-nurseries" for the production of virus-free *Lloyd George* canes were planted at the Research Station. In 1930 six daughter-nurseries were planted, each with 300 canes from the Research Station nurseries, on the farms of volunteer growers and on the Farm Institutes in Kent and Sussex. These nurseries were inspected by us twice in 1931 and twice in 1932. An average of six mosaic-infected stools have been removed from each nursery during these two years, and the labour involved in their conduct has therefore been negligible compared with their output in 1932, which ranged from 1,800 to 9,500 canes (averaging 5,600 canes) per nursery; 22,500 canes in all. The demand for virus-free cane from these cane-nurseries and from the parent cane-nursery at the Research Station, both from growers wishing to lay down such nurseries themselves, and from those requiring reliable and uniformly vigorous cane for planting fruiting plantations, has greatly exceeded the supply. Applications have been received from all parts of the country, from Scotland and from Ireland.

In view of this heavy demand for cane and the numerous enquiries regarding the establishment of cane-nurseries, the following notes on the planting up of such nurseries are offered, pending a detailed account of the above mentioned experiments which is in course of preparation for publication.

The scheme as set out has been formulated on the basis of experiments with *Lloyd George* and is at present limited to this variety. Other varieties can be included when necessary and, in the case of newly introduced varieties, when preliminary susceptibility tests have been carried out. These notes were first circulated in stencilled form to enquirers in 1931, but since the method of cane raising has now proved so successful, it is thought advisable to bring them before a wider public.

II. THE PLANTING AND MAINTENANCE OF "LLOYD GEORGE" CANE-NURSERIES.

1.—*Material for Planting.*

As mosaic symptoms may not develop for a year or more after infection, canes selected directly from a commercial plantation may appear to be perfectly healthy and yet may in fact be infected with the disease. Thus, as the success of the nursery depends on planting up with a batch of canes containing not more than 1 per cent of infected material, *it is essential* to obtain such cane direct from the parent nursery at the Research Station or from a cane-nursery planted with such cane and subsequently carried on *under expert supervision*.

2.—*Situation of the Cane-Nursery.*

In order to reduce to a minimum the risk of mosaic infection from outside sources (and also infection by cane-spot and other fungus diseases) the cane-nursery should be situated as far as possible, and not less than 50 feet away, from the nearest fruiting plantation of raspberries.

3.—*Mode of Planting.*

Distance between rows : as far apart as practicable and not closer than 6 feet.

Distance between plants in row : 2 feet 6 inches or preferably 3 feet.

4.—*Cultural Treatment.*

At Planting. All cane to be cut down to about 6 inches from the ground.

At the end of the first growing season. If the stools have made poor growth all the canes should be cut down close to the ground and the roots left undisturbed. If the stools have made good growth and vigorous cane all the canes should be dug out with a spade, inserting the spade as close to the cane as possible, thus making sure of leaving sufficient root spawn in the ground to furnish the row the following year.

In subsequent seasons. Every cane, including small spawn, should be dug out annually as described above, *leaving no fruiting canes in the nursery*.

The main objects of the above treatments are :

(1) To secure a supply of vigorous and well-rooted canes, all old roots being automatically eliminated.

(2) To ensure that the canes are sent out free from the important fungus diseases, *Cane-spot*, *Cane-blight* and *Spur-blight*.

A certain amount of blossom is bound to appear in the cane-nursery, and should be periodically removed in order to guard against the introduction of seedling rogues.

5.—*Manuring and Cultivation.*

Every effort should be made to encourage strong, healthy growth of cane by frequent and thorough cultivation and by judicious manuring. Recent experiments at East Malling have shown that on some soils heavy manuring with nitrogenous artificials may, after a time, decrease cane growth. In such soils dressings of potash may be needed to restore the balance.

6.—*Roguing.*

(a) *Time.* As pointed out above, the special material used for planting up such cane-nurseries is known to contain not more than 1 per cent infected canes. Such infected canes, and any cases of subsequent natural infection that may occur, are eliminated by systematic inspections and roguing. At least two inspections annually should be made. The best times for such inspections are in *early July* and in *early September*.

(b) *Method.* During the first and possibly the second season, each stool is examined closely and if any canes show Mosaic symptoms, the whole stool should be immediately dug up, *together with those adjoining on either side*, and burnt.* In doing this, care should be taken to see that all roots are removed and burnt and that no rogued plants are left lying in the nursery rows. This immediate destruction of rogued stools is necessary on account of the danger of infection spreading to healthy plants. When the rows become a solid mass of cane, great care must be taken to remove all canes showing mosaic symptoms, and a space of *at least 3 feet must be cleared on either side of such canes*.

The position of rogued stools or canes should be marked with a stake and care should be taken to keep the space round such stakes free from spawn for at least one year ; on no account should these gaps be replanted until after this period has elapsed. On the other hand, gaps caused by the natural failure of stools to grow may be replanted immediately with cane from other parts of the same cane-nursery.

7.—*Rotation of Nursery Rows.*

Roguing operations are always easiest in newly planted nursery rows. For this reason, it may be advisable where space permits, to make fresh plantings periodically, especially in the case of a strong growing variety like Lloyd George. Under good soil conditions the rows of this variety may become so unwieldy after three years as to make detailed inspection a lengthy process. It may therefore be found advisable to lay down fresh rows every second or third year, grubbing the older rows as soon as the new ones come into bearing. Such a procedure would also minimize the danger of rogue seedlings becoming established in the nursery.

SUMMARY.

1. The investigation of raspberry-mosaic disease started in 1921 at East Malling has indicated that, although the roguing of commercial fruiting plantations is impracticable, a satisfactory control can be achieved by a system of "cane-nurseries" established solely as a source of supply of cane free from the mosaic-virus, for the planting up of commercial plantations.

2. Recommendations are given for the planting and maintenance of "Cane Nurseries" of the variety Lloyd-George.

* The success and reliability of a nursery largely depends on the accurate identification of infected stools, to achieve which considerable practice and experience are necessary, and on the immediate removal and destruction of such stools.

NUCICULTURE

WALNUT GROWING IN ENGLAND—PRESENT AND FUTURE*

By J. B. HAMOND

“A woman, a dog and a walnut tree,
The more you whack them the better they be.”

IF the average Englishman is asked what thought springs to his mind in connection with the word “Walnut” he will very probably reply with the words of this well-known rhyme. Everyone is familiar with it, although most people have some doubt as to its truth—when applied to the *walnut tree*!

Tradition has it that a walnut trunk which is occasionally injured by flogging with chains will respond by producing the well-known galls or “burrs”, which in section, show the beautiful, wavy markings that make this wood so valuable for panelling furniture. Unfortunately, there seems to be little or no support for this idea, and a serious stem-rot is a much more probable outcome of such treatment.

Originally walnuts were probably beaten with long poles in order to bring down the nuts while they were still green and ready for pickling. As a result of such treatment little pieces of twig were inevitably knocked down at the same time. Where a terminal bud has been knocked off, several lateral buds grew out in the following Spring, and produced two or three fruiting shoots instead of only one. Hard pruning is unsuitable for walnut trees as it results in vigorous vegetative growth as distinct from short, fruiting shoots. This “whacking” of walnut trees with long poles therefore achieves the double purpose of bringing down the nuts and providing sufficient pruning to increase the fruiting capacity of the tree.

On travelling up and down the country, one cannot fail to be struck by the charm of the hedgerow trees that form such a prominent feature of the English wayside. Avenues of majestic elms and clusters of spreading chestnuts are common in all parts of England, and recently some of us have been considering the possibility of planting up similar avenues and copses of walnut trees. These trees are second to none in beauty of growth and spreading habit, and in them beauty is combined with utility.

How picturesque an avenue the walnut will make is seen by the one in the grounds of Leeds Castle, near Maidstone, and by several other fine examples of this method of planting that are to be found near Wells in Somerset. The trees should stand far enough apart both in the rows and between the rows to have plenty of light and air around them. The full charm of their spreading, umbrella-like habit of growth is then seen to advantage. It is this characteristic growth which makes these trees eminently suitable for giving shade in the hedgerows, and providing shelter for grazing animals in open fields. If one is planting for posterity alone there is no tree to surpass the walnut. One of these magnificent old trees stands at Minster in the Isle of Sheppey, and it is estimated that it has stood there for the past 500 years. This tree has a spread of a quarter of an acre and a trunk of 11 feet in circumference; in the time of Queen Elizabeth it must have been giving shade and bearing nuts as it is to-day.

* Reprinted from *Country Life*, 19th November, 1932.

It may be remarked at this point that walnut trees are already common in England, but it cannot be denied that the vast majority of these trees have been grown from seed and bear very inferior nuts, while many never bear a crop at all. One is only too familiar with the English walnuts which appear in the shops for about a fortnight at the end of October—small nuts, nearly black in colour, the two halves of the shell usually ready to separate on pressure from the fingers, disclosing an unattractive-looking kernel which frequently by no means fills the shell and is surrounded by a thick, brown skin. The work of peeling a kernel is tedious and often very difficult, but usually necessary on account of the extreme bitterness of the skin which completely masks any flavour the kernel may possess. In the majority of cases, however, the flavour of the kernel is either watery and insipid, or faintly sugary; rare indeed are those with the rich nutty flavour characteristic of a good walnut. When this dismal picture is compared with that of the attractive walnuts from France and California which appear in our shops about Christmas time, when our own supplies have long since been exhausted, we have reason to pause and consider whether something could be done to improve the quality of the walnuts produced in England. These nuts which come over from the walnut-growing areas abroad are all named varieties, many of which, in recent years, have been found to grow well in this country. The nuts are of a medium size and have been bleached to an attractive light colour. The rich fully-flavoured kernels, practically filling the shells, are surrounded by thin, papery skins which are almost flavourless, and therefore need not be removed before eating the nuts. In view of this prevailing state of affairs, it is small wonder that home grown walnuts are of little account and totally inadequate to supply our needs.

When any attempt is made to store the average English walnut it becomes mouldy, or shrivelled and useless within a few weeks, but the problem of storing selected English walnuts during the winter has been studied at East Malling Research Station during the last few years. It has been found that two factors are all-important in keeping walnuts plump and free from moulds during the winter. Firstly, the nuts must be well-sealed (i.e. the two halves of the shell must not gape open when pressed with the thumb and forefinger), and secondly, every trace of the green outer husk must be removed before they are stored, as it is on this that moulds commence to grow, and afterwards penetrate the shell and attack the kernel. Where walnuts are grown on a large scale, mechanical washers are used for removal of the husk, but this can be accomplished quite successfully on a small scale with a soft brush in water. After washing they should be put in a single layer, preferably in a current of air, where they will dry quickly. To improve the colour of the shells and to make them more resistant to fungi, they may be dipped in a bleaching solution prepared from chloride of lime. When dry, the nuts are placed in any convenient vessel, such as an earthenware crock filled with alternate layers of nuts and salt, and kept in a cool place. By this method, well-sealed nuts have been stored successfully from October until the following May.

As a result of long experience on the Continent and in California, it has been found that walnut seedlings are almost as variable as apples, and hence vegetative propagation must be employed in order to raise reliable trees.

During the last few years the possibility of improving the production of walnuts in this country by planting up grafted trees of good, named varieties was stressed by Mr. Howard Spence, who sought the collaboration of East Malling Research Station because of its work on the vegetative propagation and standardization of fruit plants. The first step was to select a few established trees of special merit from which to propagate. After a survey of the walnut trees up and down the country, followed by a most successful Walnut Competition in 1929, six healthy trees were chosen on account

of the outstanding quality of their nuts. Two of these trees are situated in Kent, two in Suffolk, one in Gloucester and one in Worcester.

Material has also been collected from the walnut-growing areas in France and California and, to a less extent, from Belgium, Italy and the East. Scions have been included from parent trees known to produce the beautiful burred walnut wood which is being used more and more extensively in the production of suites of furniture and in cabinet-making. Trees that have been raised vegetatively from such material are at present too small to show any signs of burr-formation, but it is hoped that they may maintain this characteristic and thus make valuable timber.

Walnuts are grafted under glass in the spring and planted out in the nursery about the end of August. During the next two or three years they are pruned and tended, then at about 5 ft. high they are transplanted to permanent positions. These young trees need careful planting, followed by cultivation as for any other fruit-tree while they are becoming established in their new environment. Many people have a mistaken idea that when planting up walnut trees one is working entirely for future generations. As a matter of fact, nuts normally appear on a grafted tree after five or six years, and frequently even before this. A seedling is reputed to come into cropping several years later, and has the added disadvantage of bearing nuts of unknown quality.

At the end of 1931 some 624 walnut trees had been raised vegetatively at East Malling. These trees consist of some sixty-four varieties collected from all over the world. Twelve varieties which bear nuts of outstanding quality have now been selected as being especially suitable for our climatic conditions. These are all late in leafing-out, so they should escape damage to the foliage and nutlets by our late spring frosts. Seven established English trees have been included among these suitable varieties, five of them being outstanding at the Walnut Competition. The other two selected English trees bear grape-like clusters of small nuts; sometimes there are as many as twenty or thirty nuts in a bunch. These small nuts are eminently suitable for pickling, and are being propagated for that purpose. One tree is situated in an avenue of walnuts in the grounds of Leeds Castle, near Maidstone, and the other in Sussex. Samples of nuts from these trees have been tested by two leading London firms and proved to be very satisfactory for pickling purposes. The consumption of cold beef and its accompanying pickled walnuts is enormous in this country, and large consignments of green nuts for this purpose are sent over here from Belgium every year. Our climate is equally suitable for the production of nuts for pickling, and there seems no reason why we should not be self-supporting in this direction. Trees are now being grafted especially for this purpose, and we look forward to the time when trees are grown for their pickling nuts in the same way that to-day plantations of apples are grown definitely for culinary or for dessert purposes.

In addition to these English trees that have been selected for rapid propagation, four well-known French varieties have been chosen—*Franquette*, *Mayette*, *Meylanaise* and *Treyve*, also one American variety named *Woodland*. The latter, in addition to bearing nuts of outstanding quality, also bears catkins during the first few years. Most walnut trees bear only nutlets during the first five years, and these mature only if they are fertilized by pollen from an older tree. After this time both types of flower are borne on grafted walnut trees. On account of its precocity in bearing catkins, the variety *Woodland* should bring about earlier cropping than usual if planted up with other young walnut trees.

Although a few good varieties of walnuts have now been selected for rapid propagation, it is possible that the best nuts in the country have not yet been discovered. Samples of promising nuts will be welcomed at this Station, where they will be tested



Young Grafted Walnut tree bearing nuts at the age of three years.

in order to ascertain whether they reach the required standard. Before samples of nuts are submitted they should have passed the preliminary test of remaining unshrivelled, rich and palatable after being kept for a fortnight exposed to living-room temperature.

Having accomplished the necessarily slow and arduous work of surveying many walnut trees already growing in this country, and selecting from them and from foreign varieties a few suitable for growing under our climatic conditions, it is felt that it is now possible to work on a definite programme of rapid propagation, as outlined above, in order to meet the increasing demand for grafted walnut trees in the British Isles. In the last two seasons 274 grafted walnut trees of named varieties have been distributed from this Station, and planted up in copses, in avenues, in groups of two or three, and even singly. It is hoped that having now commenced to distribute the trees, it will be possible to keep up the supply from year to year. With this end in view, some 500 trees of the selected varieties were raised last year. Most of these have now been planted out in the nursery, and will be ready for distribution in the course of the next year or two.

Enquiries for grafted walnut trees have also been received from Australia, South Africa, and Palestine, and scion wood of certain varieties that do well under Californian conditions is now being produced here. From this material it will be possible to raise trees suitable for growing in warmer climates, which will meet the demand from the Dominions and elsewhere.

SUMMARY.

The natural beauty and the shade-giving habit of the walnut are used to illustrate its desirability as an ornamental tree as well as one having commercial possibilities.

Successful methods of storing the nuts are outlined,

The present poor quality of the average English-grown walnut is emphasized, and is attributed to the predominance of seedling trees. The possibility of improvement by vegetative propagation is indicated, and details are given of a scheme worked out at East Malling to test such an undertaking.

SYMPTOMS OF MANURIAL DEFICIENCIES IN HOPS

By F. H. BEARD

IN 1895 experiments dealing with the manuring of hops were carried out in several centres in Kent under the auspices of the South-Eastern Agricultural College (1). These trials were designed to study the effect of mineral manures on various types of soil, and were continued over a period of several years. The effects of the application of potash and phosphatic manures varied considerably at the different centres, potash having little effect on a heavy clay at Marden, whilst dressings of phosphatic manures and lime gave increased yields. On a light sandy loam at Frant the position was reversed, the application of potash giving increased yields. The conclusions drawn by Sir Daniel Hall, who initiated the experiments, was "that the hop plant is one which shows no special requirements in one direction or another, but is an all round feeder. It is not like the swede crop which shows a special dependence on a free supply of phosphates, or potatoes which particularly need plenty of potash, but the hop requires what may be termed a normal mixture of all the elements of plant food."

The variation in the effects of potash and phosphatic manures on different types of soil is further borne out by experiments conducted in recent years by Mr. A. H. Burgess of the South-Eastern Agricultural College (2 and 3). These trials were designed to study the effect of withholding nitrogen, potash and phosphates from the hop plant on two types of soil, one a clay at Horsmonden and the other a loam overlying the chalk at Chilham. In the earlier years of the experiment the omission of phosphates did not significantly depress the yield at Chilham, whilst at Horsmonden where the soil contained a good supply of potash and phosphates, the plants responded freely to applications of nitrogen.

Most fruit growers are now familiar with the work of Dr. Wallace of Long Ashton Research Station in establishing definite foliage symptoms associated with deficiencies in the manuring of fruit trees (4). This work has made it possible to a large extent to decide on the type of manuring required by observing certain symptoms on the trees themselves.

Following on the lines of Dr. Wallace's pot experiments with fruit trees a trial was carried out at East Malling with the object of ascertaining if the hop plant would exhibit definite symptoms of manurial deficiencies, which could afterwards be recognized in the hop garden.

Hop plants were grown for three seasons in large (18 in.) pots filled with pure silver sand and fed with the following nutrient solutions :

1. Complete nutrient solution.
2. Nitrogen omitted.
3. Potassium omitted.
4. Phosphorus omitted.
5. Calcium omitted.
6. Magnesium omitted.
7. Rain Water only.

During the first season there was not much difference to be seen between the treatments with the exception of the non-nitrogen plants. One possible explanation for this is that the plants were still drawing upon the reserves of food in the hop sets.

In the second season plants receiving the same treatments were remarkably uniform, and symptoms of deficiencies appeared, which became even more marked in the third and last season.

1. COMPLETE NUTRIENT SOLUTION.

The pot plants receiving the complete nutrient solution failed to make as good growth as under field conditions, but apart from this they were quite healthy. This may have been due to a dislike to growing in sand, or to the rather restricted root run.

2. NITROGEN OMITTED.

The effect of the omission of nitrogen was most marked. In the first season the leaves were pale green, and in subsequent years the plants were stunted with small pale leaves and were almost entirely barren. In only a few cases did plants bear one or two cones. Very few shoots were produced from the crown in the Spring, and root development was extremely poor. Nitrogen deficiency is not, however, likely to occur in well cultivated hop gardens, as the requirements of the hop plant in this direction have long been recognized.

3. POTASSIUM OMITTED.

The withholding of potassium had little effect until the third season, when the leaves were paler in colour, and bronzing and scorching occurred on the older leaves at the end of August. The growth of bine, however, was quite satisfactory. In the first two seasons cropping was good, but in the third year the cones failed to "grow out" properly, whilst root development was only moderate. In the final year half the number of plants under each treatment (except 2 and 7) received an increased amount of nitrogen and in the case of plants receiving no potassium, the effect of this was most marked. Severe scorching commenced at the tip of the bine about the middle of August and spread downwards, the cropping was very poor, the cones failing to develop and remaining small and rudimentary. It appears therefore that leaf scorch associated with potassium deficiency is closely related with the supply of nitrogen as has been shown by Wallace to be the case with fruit trees (5). *The practical importance of this finding can hardly be over-emphasized as indicating the necessity of providing adequate dressings of potash manures to supplement the heavy applications of nitrogen. This especially applies to those lighter soils which are known to be deficient in available potassium.*

4. PHOSPHORUS OMITTED.

Phosphorus deficiency was almost as stunting in its effect as the withholding of nitrogen. The leaves however were a dull dark green and down-curved, in marked contrast to the pale leaves of the nitrogen-starved plants.

Root development was very poor and the plants failed to produce cones.

5. CALCIUM OMITTED.

When calcium was omitted from the nutrient solution marginal scorching occurred on the lower leaves which dropped prematurely, but in all other respects growth was equal to that of the plants receiving the complete nutrient solution. The effects of a calcium deficiency under field conditions would probably be very different owing to the fact that calcium in the form of lime acts in other ways than as a direct plant food, whilst under sand culture conditions these functions are not involved.

6. MAGNESIUM OMITTED.

Magnesium deficiency gave rise to very distinctive spotting and scorching of the leaves. In the early part of the season the plants appeared healthy, but about the middle of July angular spotting occurred between the veins and around the margins of the lower leaves. This rapidly spread upwards causing premature defoliation which was sufficiently severe in the third season to prevent proper cone development. When the amount of nitrogen in the solution was increased, the scorching and failure to develop good cones was even more marked. Magnesium deficiency is not likely to occur in hop gardens in this country, but soils deficient in magnesium occur in U.S.A.

7. RAIN WATER ONLY.

The plants receiving rain water only were included in the experiment with the object of providing a control for purposes of comparison. These plants were indistinguishable from those which were starved of nitrogen.

With the object of associating the symptoms exhibited by the plants in the sand culture experiment with similar deficiencies in the hop garden, a visit was paid to the manurial trial at Chilham laid down by Mr. A. H. Burgess of the South-Eastern Agricultural College, Wye. Here the treatments were: (1) complete manuring, (2) no nitrogen, (3) no potassium, (4) no phosphorus, (5) unmanured. The symptoms exhibited by the plants on these plots resembled so closely those of the comparable sand cultures at East Malling that it was possible to identify the different treatments at sight.

Whilst the results of the three years' experiments at East Malling amply confirm the weight of empirical findings with regard to the importance of nitrogen in the growth of the hop plant, they serve also to point one or two danger signals to the hop-grower.

They have shown that there are certain very definite diagnostic characters indicative to certain deficiencies which it is unwise to ignore. They have shown also that the question of "balance" in manuring of hops is just as important as in the manuring of fruit trees.

SUMMARY.

Descriptions are given of foliage characters associated with the omission of certain elements from the nutrient solutions in a sand culture experiment, and it is shown that similar symptoms may occur in the hop garden. Growers are advised to watch for the appearance of any indication of deficiency in the soil and to modify their manuring accordingly.

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- (3) ——— "Hop Investigations, Report on Manuring Experiments, 1925." Journ. Institute of Brewing, Vol. 33. March, 1927.
- (4) BEARD, F. H. "Manurial Experiments with Hops in Pot Culture." Journ. of Pom. and Hort. Sci., Vol. X, No. 2. June, 1932.
- (5) WALLACE, T. "Some Effects of Deficiencies of Essential Elements on Fruit Trees." Annals of Applied Biology, Vol. 17, p. 649. 1930.



Foliage characters, 1930.

- | | | | |
|---|--------------------|---|---------------------|
| 1 | Complete solution. | 2 | Nitrogen omitted. |
| 3 | Potassium omitted. | 4 | Phosphorus omitted. |
| 5 | Calcium omitted. | 6 | Magnesium omitted. |

OTHER PUBLICATIONS OF GENERAL INTEREST

THE following articles written by members of the Staff for various journals during the course of the year should prove of general interest to our readers :—

- “ Root Studies II. The Root Development of an Apple Tree in a Wet Clay Soil.”
W. S. Rogers. Journ. of Pom., December, 1932.
- “ Soft Fruit for Quicker Returns.” N. B. Bagenal. Farmer and Stockbreeder,
21st November, 1932.
- “ Further Studies on the Incidence and Control of Apple Scab and Apple Mildew.”
M. H. Moore. Journ. of Pom., December, 1932.
- “ Bacterial Canker as a Cause of Die-Back in Plum Trees.” H. Wormald. Journ. of
the Min. of Agric., June, 1932.
- “ The Apple Fruit Sawfly.” A. M. Massee. Gardeners' Chronicle, 16th July, 1932.
- “ Some Observations on the Apple Blossom Weevil.” A. M. Massee. Gardeners'
Chronicle, 6th August, 1932.
- “ Some Injurious and Beneficial Mites on Top and Soft Fruits.” A. M. Massee. Journ.
of Pom., June, 1932.
- “ Further Observations on the Habits of the Raspberry Beetle with Special Reference
to the Control of the Pest by means of Derris.” W. Steer. Journ. of Pom.,
March, 1932.
- “ The Control of the Raspberry Beetle by means of Derris.” W. Steer. Kent N.F.U.
Journ., April, 1932.
- “ Blossom Wilt of Fruit Trees.” H. Wormald. Journ. of the Min. of Agric., October,
1932.
- “ Manurial Experiments with Hops in Pot Culture.” F. H. Beard. Journ. of Pom.,
June, 1932.

PUBLICATIONS

LIST OF PUBLISHED REPORTS FOR THE YEAR COMMENCING 1ST JANUARY, 1932 TO 31ST DECEMBER, 1932.

TITLE.	JOURNAL OF PUBLICATION.	REPRINTS.
TOP FRUITS.		
POMOLOGY.		
ROOT STOCKS.		
APPLES.		
E57. The Importance of the Root System in Fruit Growing. <i>W. S. Rogers.</i>	Northwest Fruit Grower (U.S.A.) (October, 1932) 4, No. 10.	No Reprints.
CHERRIES.		
E50. Some Aspects of Morello Cherry Culture. <i>N. H. Grubb, A. C. Painter and H. Wormald.</i>	Kent Cherry and Soft Fruit Show Catalogue. (16th July, 1931) East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 57-60.	Price 2d.
GENERAL.		
E51. The Planting Situation. <i>N. B. Bagenal.</i>	East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 67-69.	No Reprints.
ROOT STUDIES.		
E55. Root Studies. II. The Root Development of an Apple Tree in a Wet Clay Soil. <i>W. S. Rogers.</i>	Journ. of Pom. and Hort. Sci. (December, 1932.) 10, 219-227.	Price 2s. 4d. Reprints exhausted.
PRUNING.		
E53. The Pruning and Renovation of Apple Trees. <i>N. H. Grubb.</i>	East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 61-66. Reprinted from Berkshire Farmers' Year Book, 1932. ("The Pruning of Apple Trees, with Special Reference to Standards.")	Price 2d. Plus postage.
NUCICULTURE.		
E51. Walnut Growing in England—Present and Future. <i>J. B. Hamond.</i>	Country Life. (19th November, 1932.) No. 1870. 72, 576-578.	Price 4d. Plus postage.
SMALL FRUITS.		
GENERAL.		
Esf22. The Revival of Small-Fruit Growing in the Light of Present-Day Knowledge. <i>N. B. Bagenal, R. V. Harris, A. M. Massee and A. C. Painter.</i>	Kent Cherry and Soft Fruit Show Catalogue. (13th July, 1932.)	Price 3d.

TITLE.	JOURNAL OF PUBLICATION.	REPRINTS.
Eg3. Soft Fruit for Quicker Returns.	N. B. Bagenal. Farmer and Stockbreeder. (21st November, 1932.)	No Reprints.
E56. EXPERIMENTAL TECHNIQUE. The Conduct of Manurial Trials in the Field.	T. N. Hoblyn. Univ. of Reading Fac. of Agric. and Hort. Bull. XLI. 1931. (1932.) 26-37.	No Reprints.
F13. PHYSIOLOGY. LEAF RELATIONS. The Leaf Relations of Fruit Trees. I. A Morphological Analysis of the Distribution of Leaf Surface on Two Nine-Year-Old Apple Trees. Laxton Superb. M. C. Vyryan and H. Evans.	Journ. of Pom. and Hort. Sci. (December, 1932.) 10. 228-270.	Price 2s. 9d. Reprints exhausted.
C73. MYCOLOGY AND BACTERIOLOGY. APPLES. Some Fundamental Considerations regarding Successful Control of Apple Scab. M. H. Moore.	Fruit Grower. 7th April, 1932. 591-593. East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 73-77.	Price 2d. Plus Postage.
C79. <i>Botrytis cinerea</i> on Apple Roots. H. Wormald.	Transactions of the British Mycological Society. (May, 1932.) 16. 309-310.	No Reprints. No Reprints.
C77. Apples should be picked with their Stalks. H. Wormald.	Gardeners' Chronicle. (September, 1932.) 92. 200.	Price 8d.
C78. Further Studies on the Incidence and Control of Apple Scab (<i>Venturia inaequalis</i>) and Apple Mildew (<i>Podosphaera leucotricha</i>) at East Malling. M. H. Moore.	Journ. of Pom. and Hort. Sci. (December, 1932.) 10. 271-294.	Bulletin to be obtained only from Reading University. Price 2s. 6d.
C82. The Control of Apple Scab. M. H. Moore.	Univ. of Reading Fac. of Agric. and Hort. Bull. XLI. 1931. (1932.) 58-69.	No Reprints.
C75. Blossom Wilt of Fruit Trees. H. Wormald.	Journ. of Min. of Agric. (October, 1932.) .. 39. 620-626.	No Reprints.
C72. PLUMS. Supplementary Note on Plum Bacterial Canker. H. Wormald.	Journ. of Pom. and Hort. Sci. (March, 1932.) 10. 64.	Reprints.
C80. Bacterial Canker of Plum Trees. H. Wormald.	East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 70-72.	No Reprints.
C81. Bacterial Canker as a Cause of Die-back in Plum Trees. H. Wormald.	Journ. of Min. of Agric. (June, 1932.) .. 39. 208-217.	No Reprints.

TITLE.	JOURNAL OF PUBLICATION.	REPRINTS.
C74. Bacterial Diseases of Stone-Fruit Trees in Britain. IV. The Organism Causing Bacterial Canker in Plum Trees. <i>H. Wormald.</i> <i>See also C75.</i>	Transactions of the British Mycological Society. (November, 1932.) .. 17. 157-169.	Stencilled copies. Price 2d.
C71. <u>SMALL FRUITS.</u> Grafting as a Method for Investigating a Possible Virus Disease of the Strawberry. <i>R. V. Harris.</i> <i>See also Esf22.</i>	Journ. of Pom. and Hort. Sci. (March, 1932.) 10. 35-41.	Price 5d. Plus postage.
C68. <u>MISCELLANEOUS.</u> Notes on Plant Diseases in 1931. <i>H. Wormald and R. V. Harris.</i>	Gardeners' Chronicle. (12th March, 1932.) 91. 207-208. No. 2, 359 Gardeners' Chronicle. (19th March, 1932.) 91. 224-225. No. 2, 360 East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 47-50. Gardeners' Chronicle. (August, 1932.) .. 92. 116-117.	No Reprints. No Reprints. No Reprints.
C83. Notes on Certain Plant Diseases observed in 1931. <i>H. Wormald and R. V. Harris.</i> C76. A Bacterial Disease of Lilacs. <i>H. Wormald.</i>	Gardeners' Chronicle. (16th July, 1932.) 92. 48-49. 2377 Gardeners' Chronicle. (6th August, 1932.) 92. 101. 2380	No Reprints. No Reprints.
<u>ENTOMOLOGY.</u>		
D81. <u>APPLES.</u> The Apple Fruit Sawfly. <i>A. M. Massee.</i>	Gardeners' Chronicle. (16th July, 1932.) 92. 48-49. 2377	No Reprints.
D82. Some Observations on the Apple Blossom Weevil. <i>A. M. Massee.</i>	Gardeners' Chronicle. (6th August, 1932.) 92. 101. 2380	No Reprints.
D75. <u>RASPBERRIES AND LOGANBERRIES.</u> Further Observations on the Habits of the Raspberry Beetle (<i>Byturus tomentosus</i> Fabr.), with Special Reference to the Control of the Pest by means of <i>W. Steer.</i> Derris. D79. The Control of the Raspberry and Loganberry Beetle by means of Derris.	Journ. of Pom. and Hort. Sci. (March, 1932.) 10. 1-16. I. Kent Farmers' Journal. (April, 1932.) 4. 31. 160-162.	Price 4d. Plus Postage. Price 3d.
D76. <u>STRAWBERRIES.</u> The Tarsonemid Mite of Strawberries. <i>A. M. Massee.</i>	Univ. of Reading Fac. of Agric. and Hort. Bull. XLI. 1931. (1932.) 89-93	No Reprints.

TITLE.	JOURNAL OF PUBLICATION.	REPRINTS.
FIELD SPRAYING. D78. A Simple Method of Forecasting Insect Attacks in Orchards previous to the Spring Spraying Season. <i>A. M. Massee.</i> See also D75 and D79.	East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 78-80.	No Reprints.
MISCELLANEOUS. D77. Notes on Insect Pests for the Year 1931. <i>A. M. Massee.</i> D80. Some Injurious and Beneficial Mites on Top and Soft Fruits. <i>A. M. Massee.</i>	East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 51-54. Journ. of Pom. and Hort. Sci. (June, 1932.) 2. 10. 106-129.	No Reprints. Price 5d.
HOPS. B18. Manual Experiments with Hops in Pot Culture. <i>F. H. Beard.</i> B19. Fifteenth Report on the Trial of New Varieties of Hops. <i>E. S. Salmon.</i>	Journ. of Pom. and Hort. Sci. (June, 1932.) 2. 10. 91-105. East Malling Research Station, Kent. August, 1932.	Price 6d. Price 6d.
MISCELLANEOUS. H15. East Malling Research Station Supplementary Annual Report (19th Year). General Development and Activities.	1st January, 1931, to 31st December, 1931. (April, 1932.)	Reprints.
H17. Weather Conditions during 1931. <i>H. C. Chapelow and H. M. Tydeman.</i>	East Malling Res. Sta. Ann. Rep. for 1931. (May, 1932.) 55-56.	No Reprints.
ANNUAL REPORTS.	East Malling Research Station. (April, 1932.)	Price 2s. 6d. post free.
A15. Annual Report, 1931.		

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